"A STUDY ON DIABETIC FOOT AND ITS ASSOCIATION WITH PERIPHERAL ARTERY DISEASE"

Dissertation submitted

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DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis titled ***"A STUDY ON DIABETIC FOOT AND ITS ASSOCIATION WITH PERIPHERAL ARTERY DISEASE"*** is a bonafide and genuine research work carried

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This is to certify that "**A STUDY ON DIABETIC FOOT AND ITS ASSOCIATION WITH PERIPHERAL ARTERY DISEASE"** is a bonafide work done by **DR.S.NAGULAN,** post graduate in department of **General Surgery, Kilpauk Medical College, Chennai- 10** under my guidance and supervision in fulfillment of regulation of The **Tamilnadu Dr. M. G. R. Medical University** for award of **M.S. Degree Branch I, Part II (General Surgery)** during academic period from **March 2011** to **March 2014**

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ABSTRACT

A STUDY ON DIABETIC FOOT AND ITS ASSOCIATION WITH PERIPHERAL VASCULAR DISEASE

BACKGROUND & OBJECTIVES

Diabetic foot is a condition that includes any foot pathology that results either directly due to diabetes or due to its complications. Ulceration & amputation affects the quality of life of diabetics. The prevalence of peripheral vascular disease (PAD) has been difficult to estimate and found to vary in different studies. This study aimed to study the prevalence of peripheral vascular disease in patients with diabetes related foot problems presenting to our hospital.

METHODS

This clinical study was conducted in Kilpauk Medical College & Hospital. All diabetics who fulfilled the inclusion and exclusion criteria were enrolled for the study. After recording the pertinent information as per profoma, patients were subjected to a lower limb arterial Doppler and findings were tabulated.

RESULTS

Peripheral vascular disease was found in 38 % of patients with Diabetes Mellitus. Many patients remain asymptomatic & its prevalence is higher in lower socioeconomic group. Males have higher predilection than females. Prevalence increases with age. The most common level of arterial occlusion is femoro-popliteal segment followed by tibial segment. PAD influences the outcome of diabetic foot ulcers significantly with higher rate of amputations in these patients. Coronary artery disease & Cerebrovascular disease are significantly increased in diabetics with PAD and hence PAD is a marker of systemic vascular disease involving coronary & cerebral vessels, like myocardial infarction (MI), stroke and death.

Key words: Peripheral vascular disease, diabetic foot, Ankle Brachial Index, Arterial Doppler.

INTRODUCTION

Diabetes mellitus is a common disease all over the world and its frequency is increasing steadily in India. Though the treatment options for people with diabetes have improved, many continue to suffer from various complications of the disease. Diabetic foot related problems occur frequently and it has serious consequences like amputations of extremities.

The lifetime risk for developing foot ulcers in diabetic patients is the range of 20 to 30 %. Many studies have shown that around 80% of amputations in lower limb are preceded by foot ulcers. As age & duration of diabetes increases, the risk of foot ulceration & amputations also increases by 3 to 4 folds.

As the population with diabetes increases, more and more amputations of lower extremity can be expected in future.

The early detection of peripheral artery disease in asymptomatic patients goes a long way in reduction of major lower limb amputations & mortality. Hence, there is a need for evaluation of peripheral vascular disease in all diabetics, especially those with diabetic foot by formulating effective management protocols, thereby limiting the morbidity, mortality and social costs associated with the disease.

AIMS & OBJECTIVES

1. To study the prevalence of Peripheral arterial disease (PAD) in diabetic foot.
2. To study the average age of presentation of PAD in diabetics.
3. To study its prevalence in male and female.
4. To study the level of arterial occlusions in PAD associated Diabetic foot.
5. To study the implications of socioeconomic status in PAD with diabetic foot.
6. To study the outcome of diabetic foot patients with PAD.
7. To study the prevalence of Coronary artery disease and Cerebrovascular accidents in diabetic patients with PAD.

HISTORY

In the history of medicine, there are several evidences pointing out to diabetes related foot diseases and its treatment in the past. Recently an ancient Egyptian Mummy was discovered with amputated toe for which a toe prosthesis made of leather was used. There is evidence from the mummies of Ramses II, that there existed calcific atherosclerosis in the leg vessels around 1200 BC. There is also evidence of treatment i.e. cutting away the mortified parts for gangrene foot in Hippocrates text. In the Book of Kings from Bible, there is reference to King Asa who became diseased in his feet & slept with his fore fathers[1] which is speculated by some as the first recorded case of diabetic gangrene of foot in poorly controlled Type II diabetes.

Review of Literature

REVIEW OF LITERATURE

Diabetic foot is a condition that includes any foot pathology that results either directly due to diabetes or due to its complications. WHO describes that the foot of a diabetic has potential risk of pathologic consequences like infection, ulceration, destruction of deep tissues associated with or without peripheral neuropathy, and or various degrees of peripheral vascular disease with metabolic complications of diabetes.

Complications of diabetic foot like ulceration and amputation affects the quality of life for patients. It creates an economic burden for both the patient and the health care system. Hence it is important to identify patients at risk of foot ulceration, put a proper plan for identification of such patients and apply best treatment plan.

PATIENTS AT RISK OF FOOT ULCERATION[38, 40]

- Long duration of diabetes
- Poor diabetes control
- History of previous foot ulceration or amputation
- Peripheral neuropathy
- Peripheral vascular disease
- Trauma (ill footwear, walking barefoot)
- Foot deformities (prominent metatarsal heads, claw tow, hammer toe, pes cavus, nail deformities, deformities due to previous trauma and surgery,bony prominences)
- Callus
- Neuro-osteoarthropathy
- Limited joint mobility
- Low socioeconomic status
- Poor access to healthcare services
- Poor education
- Solitary lifestyle
- Poor compliance by the patient with medical instructions and
- Neglecting to follow procedures

PERIPHERAL VASCULAR DISEASE

PAD is a manifestation of atherosclerosis characterized by atherosclerotic occlusive disease of the lower extremities and is a marker for atherothrombotic disease in other vascular beds such as heart and brain. The prevalence of peripheral vascular disease has been difficult to estimate and found to be around 13–45% in various studies.

EPIDEMIOLOGY OF PAD IN DIABETES

Framingham Heart Study [2] revealed that 20% of symptomatic patients with PAD had diabetes, but this probably greatly underestimates the prevalence, as most people with PAD are asymptomatic. It has been reported that of those with PAD, over one-half are asymptomatic or have atypical symptoms, about one-third have claudication, and the remainder have more severe forms of the disease [3] .Penn I et al found the prevalence of PAD to be 22 % with absent ankle pulses in 13 %.It has been documented in some studies that more than 50 % of subjects with diabetic duration for 10 to 15 yrs would have developed peripheral vascular disease[4].

IMPACT OF PERIPHERAL VASCULAR DISEASE

In this modern era of science & technology, as advances in diagnosis and management of various acute and chronic diseases are increasing at a rapid pace, amputations due to diabetes is also increasing at a rapid pace. While many remain stable in their lower limb symptoms for quite some time, there is high risk of developing nonfatal events (Myocardial infarction and Stroke) up to 20 % and can have mortality of up to 30 % [5]. In other words, PAD is a marker of systemic vascular disease involving coronary, cerebral, and renal vessels, like myocardial infarction (MI), stroke, and death[6, 26, 33]. The phenomenon of diabetes related complications is recent to country like India and as we are moving towards the peak of epidemic in Diabetes, it can be easily expected to have a severe impact on economy in coming days. Thereby reducing the quality of life of patients & increasing the burden on the remaining working population and health systems.

RISK FACTORS FOR PAD

Diabetes[32], Smoking, hypertension[47], Advanced age, hyperlipidemia[7], elevated C-reactive protein[44], apolipoprotein, lipoprotein(a)[42], fibrinogen & plasma viscosity[41, 43, 44].

Alcohol consumption has inverse relationship with development of PAD.

Diabetes is most strongly associated with femoral-popliteal and tibial i.e. below the knee PAD, whereas other risk factors like smoking and hypertension are associated with more proximal disease in the aorto-ilio-femoral vessels.

ETIOPATHOGENESIS OF PAD IN DIABETES

Diabetes mellitus influences nearly every vascular bed. Patients with Diabetes and PAD show endothelial and vascular regulation abnormalities[8]. It is known that the changes in the arterial structure and function predate the clinical diagnosis of diabetes. The effect of diabetes on the atherothrombotic milieu of peripheral vasculature is unique. Diabetes causes inflammation of vessels, derangements in the cellular components of vasculature, changes in hemostatic factors and blood cells. It is a well established fact that inflammation is a risk factor for atherothrombotic diseases including PAD [9].

Elevated C-reactive protein (CRP) levels have a strong association with peripheral vascular disease and is considered a marker. It is elevated abnormally in patients with diabetes & glucose intolerance. They cause accumulation of

oxidized LDL in atherosclerotic plaques, inhibits endothelial cell nitric oxide synthase (eNOS), stimulate production of procoagulant tissue factor, leukocyte adhesion molecules and chemotactic substances by the endothelial cells. Normally nitric oxide(NO) causes inhibition of vascular smooth muscle cell (VSMC) migration and proliferation & limits platelet activation, thereby causing vasodilatation and limiting inflammation . Loss of NO homeostasis due to several reasons like hyperglycemia, insulin resistance and free fatty acid (FFA) production is a final common pathway in the endothelial cell dysfunction[10].

Additionally abnormalities in rheology i.e. elevation in blood viscosity and fibrinogen levels are seen in diabetics leading on to a hypercoagulable state[11].

CLINICAL PRESENTATION & EXAMINATION

Diagnosing PAD early is very crucial, because it can reduce the functional disability and limb loss. Also very importantly it can identify a patient who is at high risk of developing a myocardial infarction or stroke. The

symptomatology of PAD when it is associated with Diabetes is varied because of peripheral neuropathy which impairs the sensory feedback.

Though the most common symptom of PAD without sensory neuropathy is intermittent claudication, it can also present late with rest pain, ulcer in foot and gangrene of toe, foot or the entire leg. Critical limb ischemia (CLI) is a collective term including chronic ischemic rest pain, ulcers or gangrene attributable to objectively proven arterial occlusive disease[12].

On the other hand, patients with peripheral neuropathy will elicit subtle symptoms of slow walking velocity and easy leg fatiguability which they usually attribute to getting older.Hence most of these diabetics experience worst kind of lower limb dysfunction[13] at a later date as they are prone to develop suddden ischaemia of their lower limb due to arterial thrombosis[12] .

Clinical examination includes:

- Palpation of peripheral pulses
- Measurement of Ankle Brachial Index(ABI)

Though palpations of peripheral pulses are not very sensitive, it remains the cornerstone of screening for peripheral vascular disease. The absence of two or more pulses on both feet is diagnostic of peripheral vascular disease[45].

Based on the results of clinical examination, a decision is made as to whether to proceed with more sophisticated methods of examination of the lower extremities in order to determine the exact level and degree of the arterial obstruction[45].

Fontaine Clinical Staging of PAD

- *Stage I* : Asymptomatic; numbness in legs (+) or (-).
  Usually Superficial femoral artery is stenosed at the level of the Hunterian canal; lateral circulation of the deep femoral artery maintains adequate perfusion for the needs of the limb.

- *Stage II* : Intermittent claudication.

- *Stage IIa* : can walk without symptoms for more than 250 m

- *Stage IIb*, if they have to stop earlier.

  Note: If patients feel pain in the leg, it is usually due to occlusion of the femoral artery, while an occlusion of the iliac artery causes pain in the thigh.

- *Stage III* : Rest pain in limbs.

  May become constant ,usually during night.It is usually resistant to analgesics. The prognosis is poor. Half of them require amputation within the next 5 years

- *Stage IV* : Gangrene.

TYPES OF DIABETIC ULCERS

Diabetic ulcers are of three types-neuropathic, ischemic and neuro-ischemic[14]. Neuropathy is present in about 85–90% of them and ischemia in 40–50% of them.

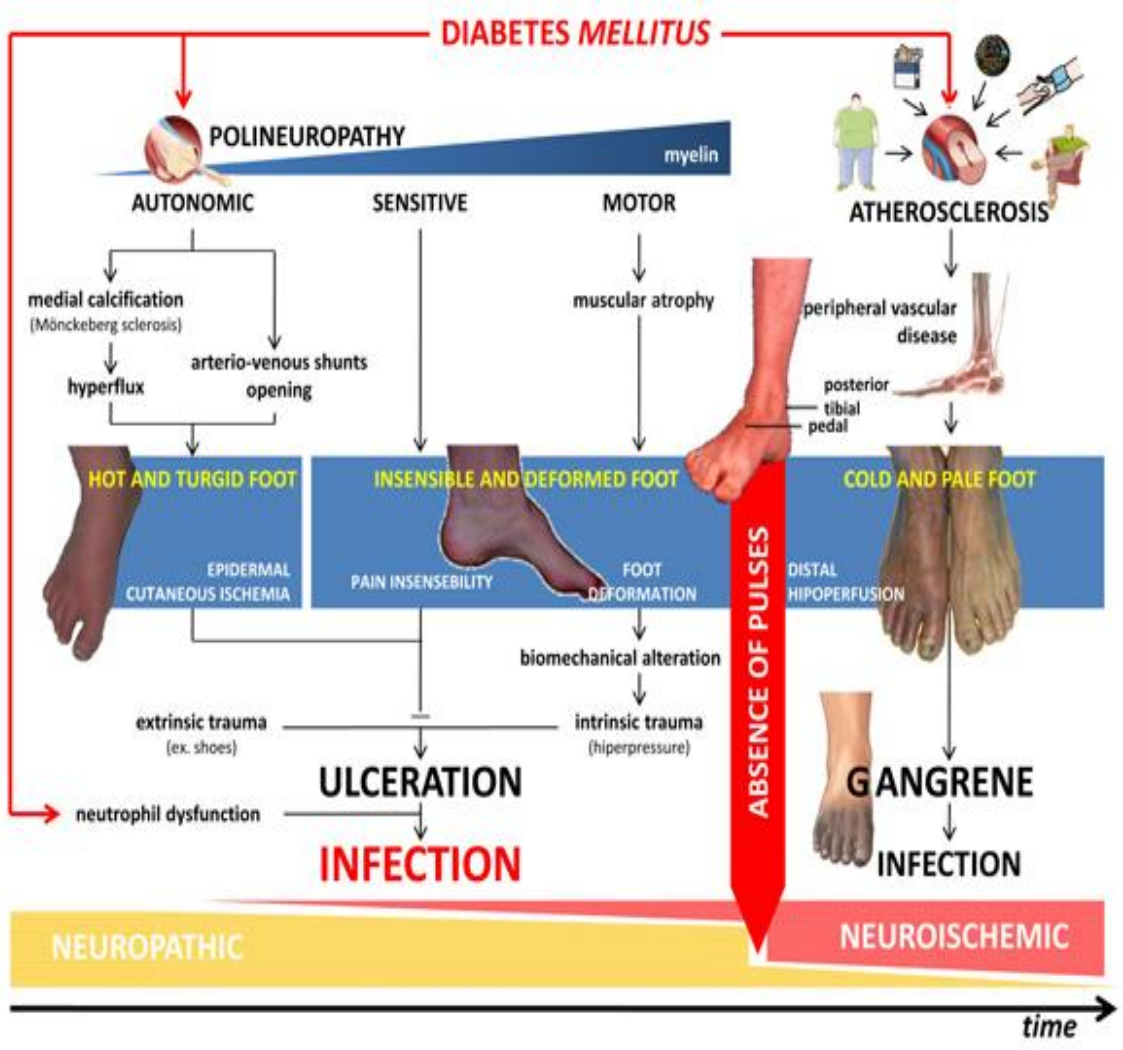


Fig.1 Pathways to foot ulceration in diabetic patients

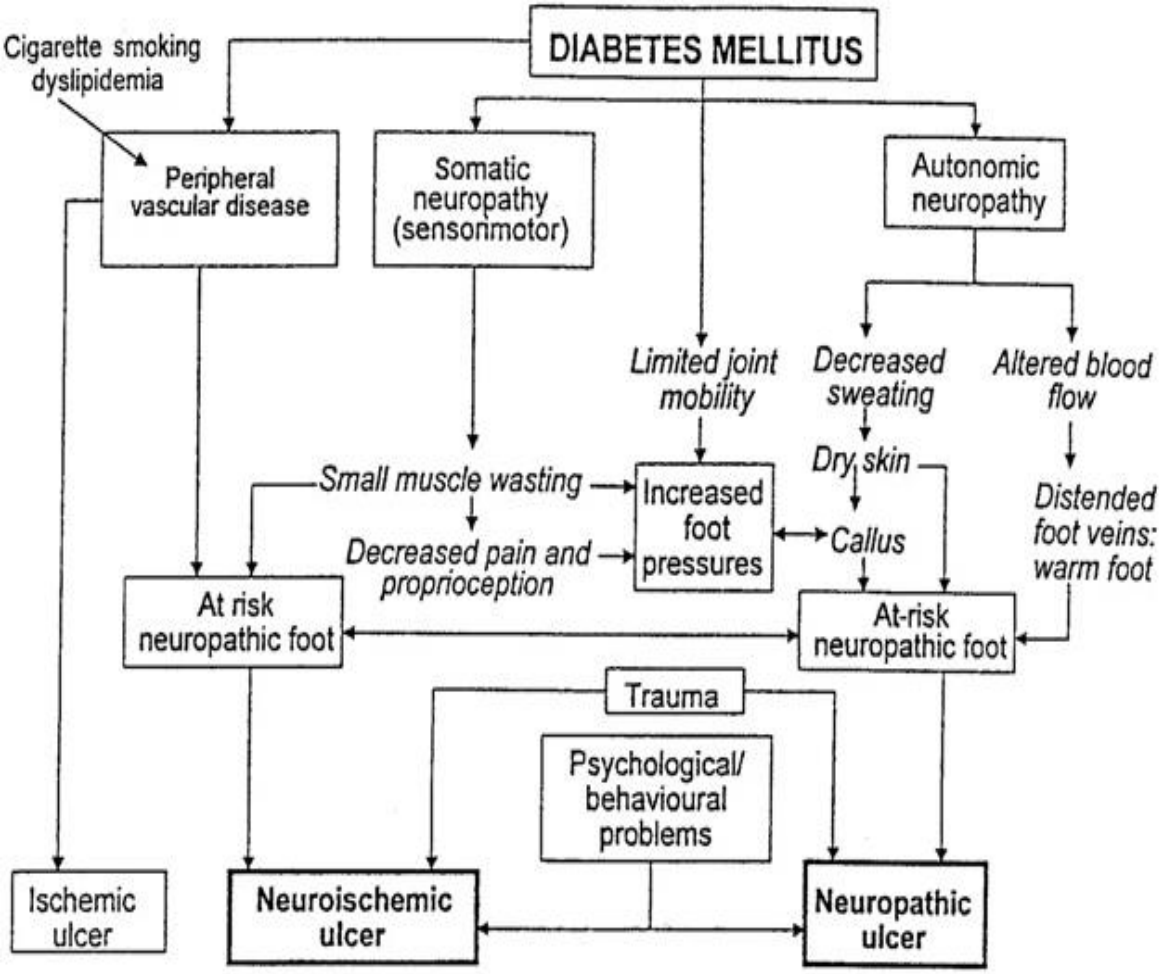


Fig .2 Flow chart showing the mode of development of all three types of diabetic ulcers

NEUROPATHIC ULCERS

These are painless ulcers that develop at sites of high plantar pressure like heel, plantar aspect of great toe & metatarsal heads. They can also be seen in Charcot –type foot over bony prominences. It has a healthy granular appearance with callus formation at its edges.

Evidence of peripheral neuropathy is seen on examination which may vary considerably from patient to patient.

- Hypoesthesia /complete loss of sensation of light touch, pain & temperature.
- Loss of vibration sense
- Dry skin
- Distended veins over dorsum of foot
- Absence of Achilles tendon reflexes
- Atrophy of the small muscles of the feet

Fig.3 Neuropathic ulcer over metatarsal head

Fig.4 Dry skin (Neuropathic foot)

ISCHEMIC ULCERS

Ischemic ulcers are seen in patients with history of intermittent claudication with no symptoms or signs of peripheral neuropathy.

They appear as yellowish or black (necrotic tissue) ulcers with red edges seen over dorsum of feet, toes or between toes.

Skin appears shiny, pale with loss of hair & onychodystrophy. On palpating, skin feels cool, thin with weak or absent peripheral pulsations.

Ankle Brachial index (ABI) is <0.9 indicating the presence of peripheral vascular disease.

Duplex or triplex ultrasound examination, segmental pressures measurement, plethysmography (which are components of non-invasive vascular testing), and angiography confirm the presence of peripheral vascular disease.

NEURO-ISCHEMIC ULCERS (MIXED ETIOLOGY ULCER)

The presence of neuropathy and ischemia in the pathogenesis of such ulcers give rise to their mixed appearance.

Fig.5 Neuro-Ischaemic ulcer with cellulitis over medial aspect of foot

DIAGNOSIS

NONINVASIVE VASCULAR TESTING

Ankle Brachial Index (ABI)

It is a noninvasive, quantitative measurement of the patency of the arteries of lower limb. Its sensitivity is 95 % and specificity is 100% and can be used in the outpatient clinic[25]. The systolic blood pressures in the ankles (dorsalis pedis and posterior tibial arteries) and arms (brachial artery) are measured at a beam vessel angle of approximately 60◦ using pocketsize continuous-wave Doppler probe[34] of 4 or 10 MHz.

$$\text{ABI} = \frac{\text{Highest ankle systolic pressure}}{\text{Highest brachial systolic pressure}}$$

When no audible signal is heard from the foot arteries a search is done for peroneal collateral signal anteriorly , which is usually next to the lateral malleolus. It is 95% sensitive and almost 100% specific [16, 18]

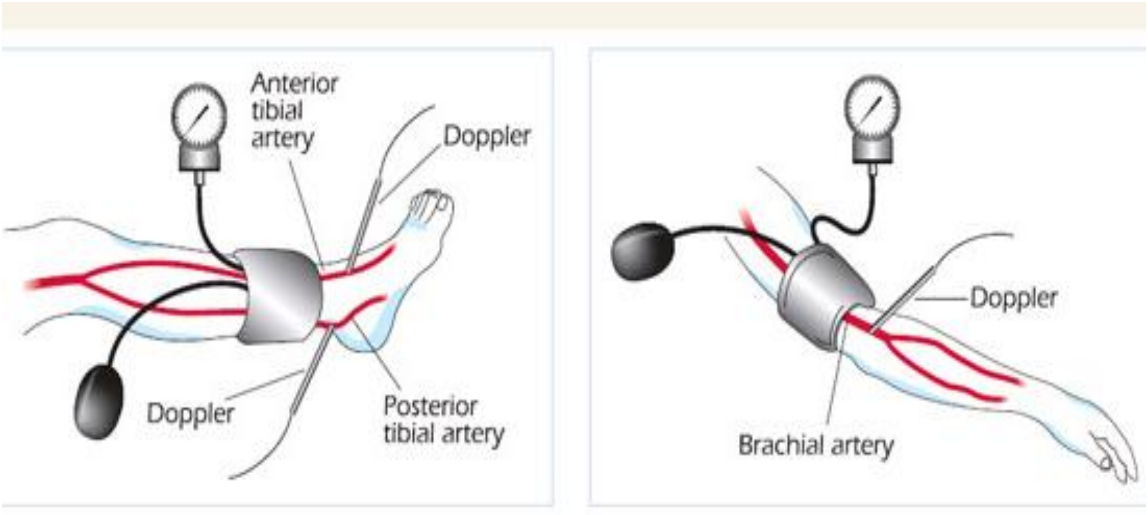


Fig.6 Measurement of ABI

NORMAL	ABI is 1 to 1.2 or Systolic ankle pressure exceeding systolic arm pressure by 12–24 mmHg
OCCLUSIVE ARTERIAL DISEASE	ABI = 0.3 – 0.9
CRITICAL LIMB ISCHEMIA	ABI <0.3 in the presence of rest pain or tissue damage or Systolic ankle pressure of <50 mmHg or equivalent toe systolic pressure of 30 mmHg or less

Limitations of ABI:

Artificially elevated values :

1. Calcified, poorly compressible vessels in the elderly
   Medial calcification is common in diabetes which makes the underlying arteries incompressible, resulting in spuriously high ABI values (more than 1.2).
2. Too high positioning of the upper body
3. Chronic venous insufficiency
4. Significant ankle edema.

In such cases, the severity of arterial occlusive disease can be assessed by toe pressure measurements.

Fig.7 Calcification of the posterior tibial artery

Artificially lower values :

1. Symptomatic patients with moderate aortoiliac stenoses.
2. Rapid deflation of cuff
3. Excessive probe pressure
4. Insufficient rest period

A change of >0.15 in the ABI during follow-up implies significant narrowing and it is an indication for further study with angiography.

A spontaneous rise in the ABI is usually attributable to the development of collateral circulation.

Using ABI, one recent survey [23] has found a prevalence of PAD in people with diabetes >40 years of age to be 20%, which is greater than anticipated, using less reliable measures, such as symptoms or absent pulses.

Another survey of patients with diabetes >50 years of age showed a prevalence of PAD of 29% [24]. Thus, the prevalence of PAD in diabetes appears to be higher than previously estimated[46].

Toe Pressures

Toe pressure can be measured either by using a flow sensor like photoplethysmograph or a digital strain guage. A pneumatic cuff with a diameter of about 1.2 times that of digit and wrapped around the proximal phalynx and sensor placed distally[16].

Toe pressures do not differ between patients with and without diabetes. Average normal toe pressure is 24-40 mmHg or less in comparison to ankle pressure.

When toe pressure is ≤30 mmHg, rest pain and skin lesions are present in most of the subjects.

Spuriously high toe pressures due to arterial calcification seldom occur at the toe level. For this reason, toe pressure determination is valuable in diabetic patients when an ankle pressure is abnormally high

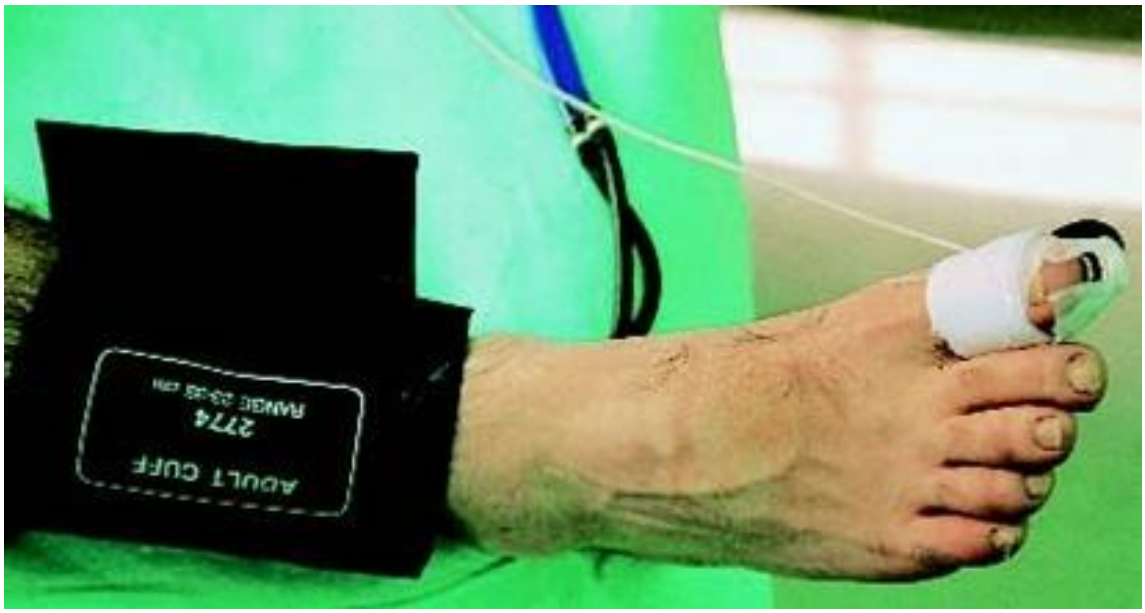


Fig.8 Measuring Toe pressure

Transcutaneous Oximetry

Transcutaneous Oximetry is a test used for the assessment of PAD[16]. It involves measurement of transcutaneous oxygen pressure, usually over the dorsum of feet with the patient in supine position. It is denoted by TcPO2.

TcPO2 values decrease with age

Normal subjects have values of 40 to 70 mmHg. In general, a resting TcPO2 greater than 55 mmHg may be considered normal, regardless of age. Patients with anemia may also have lower values.
Patients with rest pain or gangrene have values between 0 and 30 mmHg. In diabetes, TcPO2 is lower than in age matched arteriopathic patients.

- TcPO2 <40 mmHg : poor wound healing
- Increase in TcPO2 after angioplasty or bypass surgery predicts the success of procedure.
- It is particularly valuable in diabetic vascular disease as the results are not affected by arterial calcification.

Fig.9 Transcutaneous oximetry

Segmental Pressures Measurement

Though all the above mentioned tests which measure abnormal blood pressure values ,indicate the presence or absence of arterial occlusive disease, they do not identify the segment involved[16] .

Further diagnostic information can be obtained by measuring pressure gradients in the legs. However, only rarely do these measurements need to be made when the ABI is normal.

Using pressure cuffs of size 10-12 cm width, segmental pressures in lower limbs are measured by applying them at the ankle, below knee, above knee and around the thigh.

Fig.10 Segmental Pressure measurement

The pressure at the level of the inflated cuff is then measured by listening with a doppler probe over the pedal arteries i,e posterior tibial or dorsalis paedis.

PRESSURE INDEX : $\frac{\text{Segmental systolic pressure}}{\text{Brachial systolic pressure}}$

Normal pressure index ≥ 1

At the high thigh level it is 1.3.

PRESSURE GRADIENT between any two adjacent levels	
<20–30 mmHg	Normal
>30 mmHg	Significant stenosis is present at the intervening arterial segment
>40mmHg	Artery is occluded at the intervening arterial segment

Some patients with severe stenosis at a proximal level (e.g. aortoiliac disease) & severe superficial femoral artery stenosis have spuriously normal pressure gradients between high thigh and low thigh.

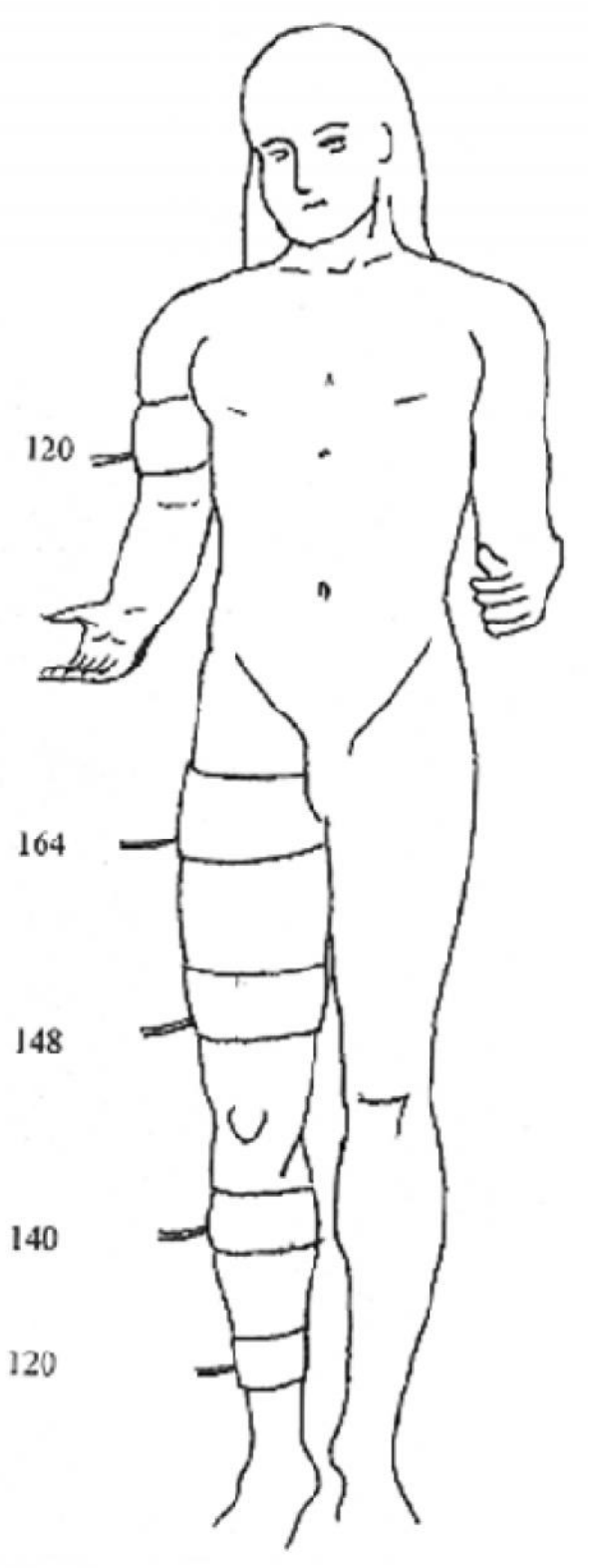


Fig.11 Normal segmental pressures

Segmental Plethysmography

When a pulse wave fills the arteries, the momentary change in the volume of soft tissue is measured by PLETHYSMOGRAPHY[16]. As in segmental pressure measurement, pressure cuffs are applied at different levels of lower limb.

It is a valuable tool for the assessment of PAD in diabetics, as it is not affected by the presence of calcification in arteries.

There are various types of them like mercury, air, strain gauge or indium-gallium plethysmographs.

As a standard, air plethysmographs are used for segmental plethysmography commonly.

Photoplethysmography works by the principle of detecting the reflection of the applied infrared light from the cutaneous microcirculation, thereby measuring blood concentration in microcirculation.

Normal segmental pulse volume contour:

- Steep vertical upstroke - systole
- Down slope that bows towards baseline - diastole
- Middle of the down slope - a prominent dicrotic wave.

When there is an arterial stenosis, the wave pattern changes distal to the stenosis:

- Upslope is less steep
- Peak becomes rounded
- Down slope bows away from the baseline
- Dicrotic wave disappears

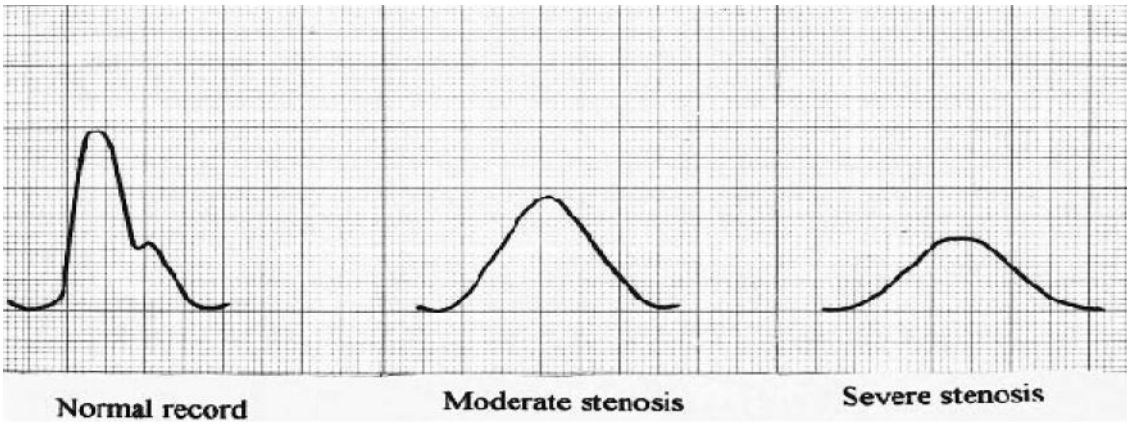


Fig.12 Plethysmograph showing normal wave & various degree of arterial stenosis

Ultrasonography

Arterial ultrasound is a simple and low cost method for identifying the site and degree of stenosis. It can also be used to check the patency of vessels after revascularization[16, 17].

Duplex ultrasonography is 80% sensitive and 90 % specific in detecting stenosis of femoral and popliteal arteries as compared with angiography. It is less reliable for the assessing the severity of stenosis in the tibial and peroneal arteries.

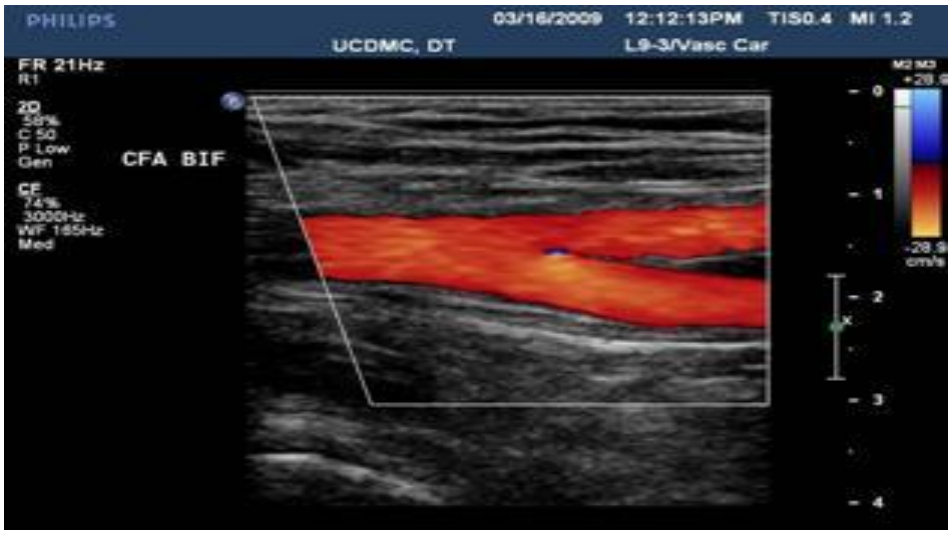


Fig.13 Duplex ultrasonography

Other Methods

Computed tomography (CT) either helical or spiral and magnetic resonance angiography(MRA) are two modern methods for the assessment of peripheral arteries.

Spiral CT is very valuable in the evaluation of large arteries like thoracic and abdominal aorta as it can generate three dimensional images ,but its drawback is that it cannot be used to assess small vessels and it requires iodinated contrast material for its imaging.

Magnetic resonance angiography is mainly used for examining the cerebral vessels and the carotid arteries. MRA might replace angiography as a primary imaging tool for peripheral vascular disease as it is a simple, nontoxic and relatively inexpensive method.

When findings are equivocal and when percutaneous intervention is planned, conventional angiography is done.

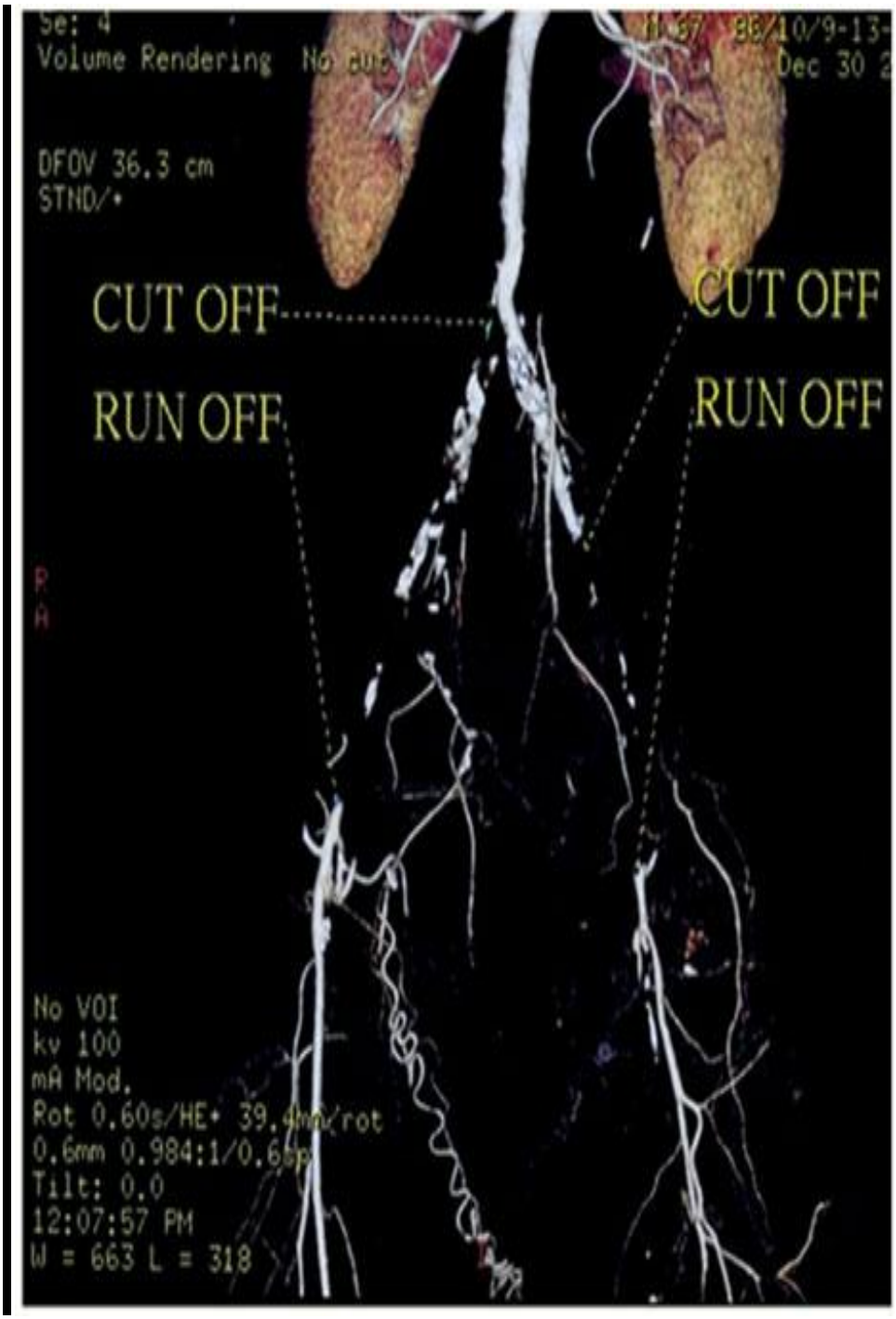


Fig.14 Multi slice computed tomographic angiography (MSCTA)

Fig.15 MRA shows a 145 mm long occlusion of the mid portion of the left SFA, collaterals from the deep femoral artery indicating the occlusion to be older. A short high-grade stenosis is seen in the mid portion of the right SFA. Posterior tibial arteries are partially occluded on both calves. Source images in the pelvis region show irregular atherosclerotic plaque material covering the posterior wall of the distal aorta, possible origin of peripheral embolism.

Invasive Vascular Testing

Arteriography

Arteriography remains the definitive diagnostic procedure before any form of surgical intervention. It should not be used as a diagnostic procedure to establish the presence of arterial disease. Contrast material may exaggerate any preexisting renal disease and for this reason the contrast material used should be limited as much as possible[16].

Arteriography remains the definitive diagnostic procedure before any form of surgical intervention. It should not be used as a diagnostic procedure to establish the presence of arterial disease. Contrast material may exaggerate any preexisting renal disease and for this reason the contrast material used should be limited as much as possible[16].

The International Meeting on the Assessment of Peripheral Vascular Disease in Diabetes strongly recommended that in diabetic patients, arteriography should be carried out before any decision regarding an amputation is made, in order to

assess the exact status of the vascular tree, particularly when the ankle brachial index and toe systolic pressure indicate that arterial disease is present.

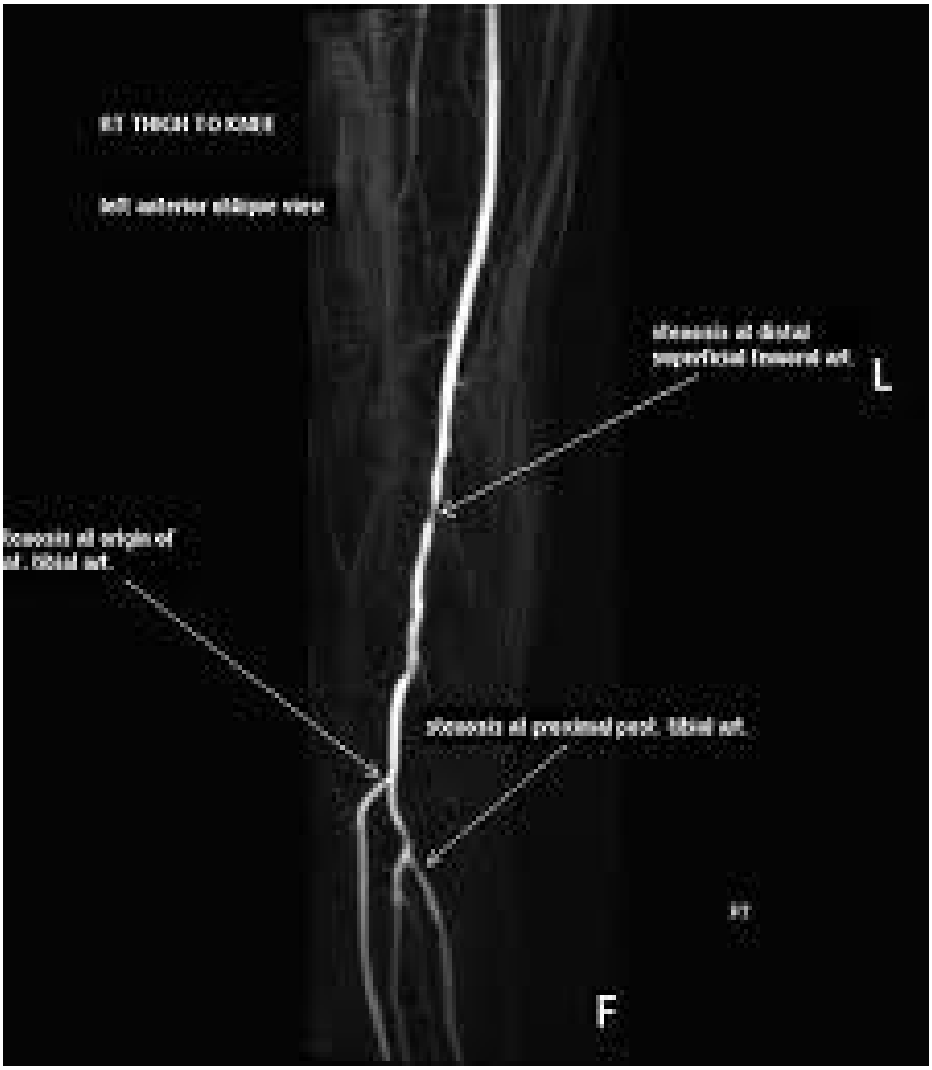


Fig.16 Arteriography

In 1993, an International Meeting on the Assessment of Peripheral Vascular Disease in Diabetes was held and following recommendations for detection and follow up of peripheral vascular disease was done[17]:

1. All Adults ≥18 yrs with diabetes

↓

History of intermittent claudication

↓

Ankle Brachial index (ABI)

↓

ABI < 0.9

↓

Intensive management of cardiovascular risk factors

↓

Cessation of smoking, control of hypertension & diabetes, weight reduction, reduction of lipid levels

2. All adults ≥18 yrs with diabetes

↓

Annual examination for signs of Critical Limb Ischemia

↓

If present

↓

Refer to specialist vascular assessment

Intense management of cardiovascular risk factors

3. All Adults with diabetes

↓

Annual examination: palpation of dorsalis pedis & posterior tibial artery,

↓

auscultation for femoral bruits

↓

If one pedal artery absent/diminished or if bruits heard

↓

Annual ABI determination

↓

If ABI< 0.9

↓

Intense management of cardiovascular risk factors

4. ABI monitoring is recommended for the following patients:

- Type I diabetes: age >35 yrs or duration of diabetes >20 yrs
- Type II diabetes: age >40 yrs
- Any diabetic with newly detected diminished pulses, femoral bruits or an ulcer foot
- Any diabetic with leg pain of unknown etiology

5. Based on the results of ABI

ABI >0.9 : Repeat ABI every 2-3 yrs

ABI 0.5 – 0.89 : Repeat ABI with in 3 months

Intense management of cardiovascular risk factors

ABI < 0.5 : Referred for specialist vascular assessment

Intense management of cardiovascular risk factors

6. Ankle pressure > 300 mmHg or 75 mmHg above arm pressure

Repeat measurements after 3 months

Still present

Referred for specialist vascular assessment

Intense management of cardiovascular risk factors

TREATMENT

For Symptomatic PAD with Diabetes

Exercise:

Exercise rehabilitation is the corner stone of therapy for intermittent claudication. The benefits of exercise training under supervision have been demonstrated in many randomized controlled trials[15, 30, 31].According to this, intermittent treadmill walking three times a week for at least three months is recommended

Pharmacotherapy:

Cilostazol is the drug of choice when drug therapy is necessary for the management of PAD in patients with diabetes. It is a phosphodiestrase type III inhibitor. It has shown to increase walking distance, limb function & quality of life[19].

Approved by FDA in 1984 for the treatment of claudication, Pentoxifylline, a hemorheologic agent was found to be inferior to cilostozol[20].

Aspirin, 80 to 325 mg/day is recommended by the American College of Physicians in the treatment of PAD, though FDA has not approved its use.

Foot Care:

Preventive foot care is of utmost importance in the management of diabetic foot with PAD.

Protective footwear should be designed in such a manner to protect the foot from shear and pressure. It is also very important that the shoe itself does no harm. A protective shoe should be sufficiently long and broad, at least 1-2 cm more than the foot width, & it must be deep enough to give full protection. Usually such shoes are made to fasten with a lace or strap high on the foot.

Several materials are used in the making of insoles like polyurethane, ethylene vinyl acetate (EVA), microcellular rubber (MCR) and cork.

Fig.17 MCR Chappal

Fig.18 MCR Chappal

Ischemic foot – Treatment

Since neuropathy blunts pain sensation in diabetics with PAD, the presentation gets delayed. The presence of PAD increases nerve ischemia, resulting in worsened neuropathy. Hence it becomes a vicious cycle when PAD and neuropathy coexist. Treatment has to be early when compared to non-diabetic patients.

Conservative management:

1. **Appropriate footwear**
2. **Dressings:** No single dressing is better than the other for diabetic wounds. However, dressings should be easily removable, should accommodate the pressure of walking without disintegrating. Non adherent dressings should cover diabetic ulcers all times[21, 22].
3. **Antibiotics**: Since infections in diabetic foot are polymicrobial, broad spectrum antibiotics are initially indicated, later followed by antibiotics according to pus culture and sensitivity. Antibiotics alone are insufficient to resolve majority of diabetic foot infections and require surgical procedures like incision & drainage (I & D), debridement and sometimes amputation of toe, toes, foot or the whole leg.

4. **Debridement**: Main aim is to make the wound free from necrotic and infective material.

   Indications : presence of localized fluctuation and drainage of pus suggestive of abscess, presence of necrotic tissue with or without crepitus , gas in soft tissues of leg on X-ray.

SURGICAL OPTIONS FOR PAD

Percutaneous transluminal angioplasty (PTA):

The blocked and narrowed area of artery is compressed against the wall by the inflated balloon, there by temporarily increasing the lumen diameter and hence blood flow to limb[39].

Balloon angioplasty & stenting: A stent is deployed and expanded at the site of narrowing following dilatation by angioplasty. In several weeks, the artery heals around the stent.

Atherectomy: A catheter with a sharp blade is used to remove plaques from the vessel lumen, especially when it occurs around branches. **Thrombolysis:** Certain drugs are used to dissolve the clots in the lumen like Streptokinase,Tissue plasminogen activator (t-PA), Tenecteplase.

Surgical Bypass: It uses a graft usually a reversed vein, to reroute blood flow to the limb around the blockage[39].

Endarterectomy: It involves open surgical removal of cholesterol plaque from the lumen of vessel.

Amputation: Amputation is a treatment of last resort. It is done in extreme cases when circulation is severely reduced and cannot be improved by any of the means discussed above.

Fig.19 Ray Amputation-Right side

Fig.20 Dry Gangrene - Right foot

Fig.21 Below Knee Amputation(Burgess)-Right side

Materials & Methods

MATERIALS AND METHODS

Patients admitted and seen in OP for Diabetic Foot ulcers between January 2013 and October 2013 in Department of General Surgery, Vascular surgery & Diabetology, Kilpauk Medical College Hospital, Chennai were taken for study

Patient's data were collected using a Proforma (Appendix 1). Factors such as age, sex and socioeconomic status were noted. History such as foot ulcer with its duration, presence of pain and its duration, numbness, discolouration, joint mobility, trauma were recorded. Duration and treatment of diabetes, family history of diabetes, previous history of surgery (amputations/disarticulations) were also recorded.

Physical examination was done to note site & size of ulcer ; presence or absence of discharge; peripheral pulsation; sensation to touch, pain and temperature; vibration perception & joint mobility.

X-ray foot, Doppler and Ankle brachial index(ABI) were taken. Follow up was done with physical examination,Doppler &ABI once in every month for a minimum of 2 months.

INCLUSION CRITERIA:

All Diabetic patients with foot ulceration

All Diabetic patients with gangrene toe

Diabetics with previous foot ulceration and amputations

Diabetics with callus over foot

Diabetics with foot deformities

Diabetics with burning sensation/pins and needles/ loss of sensation in foot

Diabetics with intermittent claudication / rest pain in feet

EXCLUSION CRITERIA:

Non diabetic ulcers

Diabetic ulcers with co-existant varicose veins /DVT

Malignant ulcers

Diabetics on Corticosteroids/Immunosuppresants

Diabetics with previous amputations for malignancy/acute trauma

Diabetics with Lymphoedema foot

Diabetics with Osteomyelitis foot

With the collected data analysis was done using a master chart (Annexure 4).

Results

RESULTS

During the study from January 2013 to October 2013 , a total of 150 cases, who were satisfying the inclusion criteria were taken up for the study. Out of 150 patients, 76 patients presented with ulcer in foot, 34 presented with gangrene of toe or foot. After clinical examination it was found that 52 patients had associated neuropathy, 17 patients had ABI less than 0.3 and 39 patients had ABI in between 0.4 and 0.9. Patients with ulcer & gangrene in foot and with ABI less than 0.9 were admitted and evaluated with Doppler study of lower limbs. Others were simply treated with cleaning and dressing and asked to wear MCR chappals. After getting consent, appropriate procedure was done for each patient. Wound Debridement was done in 21 cases, Toe disarticulation in 12, fore foot amputations in 4, Below knee amputation in 9, Above knee amputation in 3. 11 patients were referred to vascular surgery and underwent revascularization procedures (BYPASS).

Observations

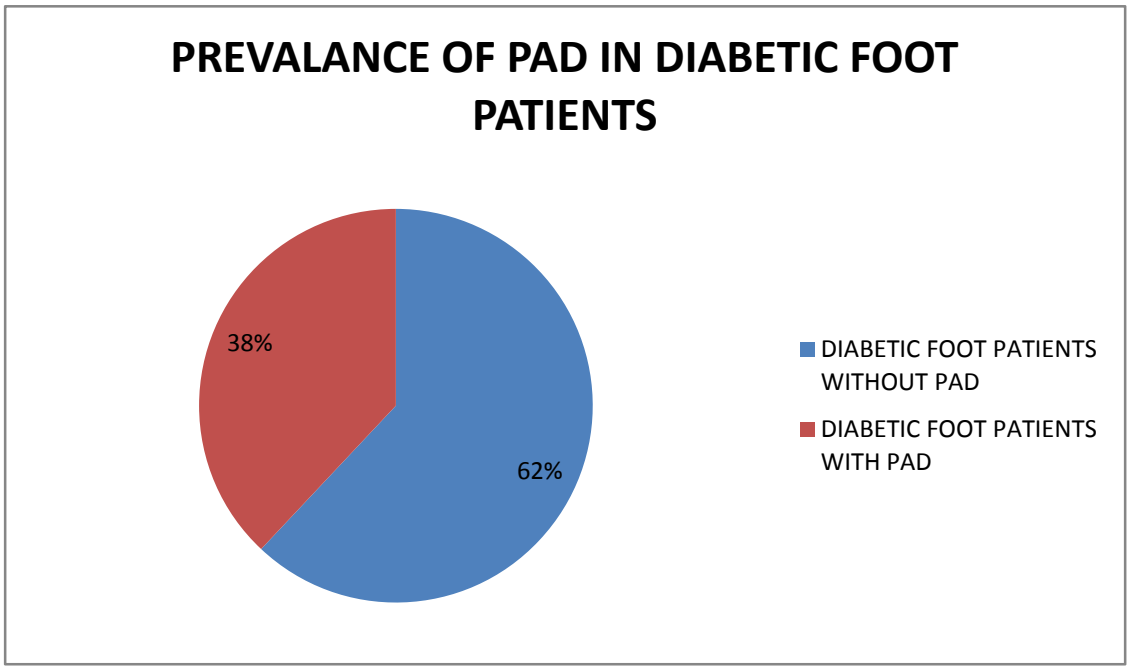
OBSERVATIONS

PREVALANCE OF PAD IN DIABETIC FOOT PATIENTS

Prevalence of PAD in

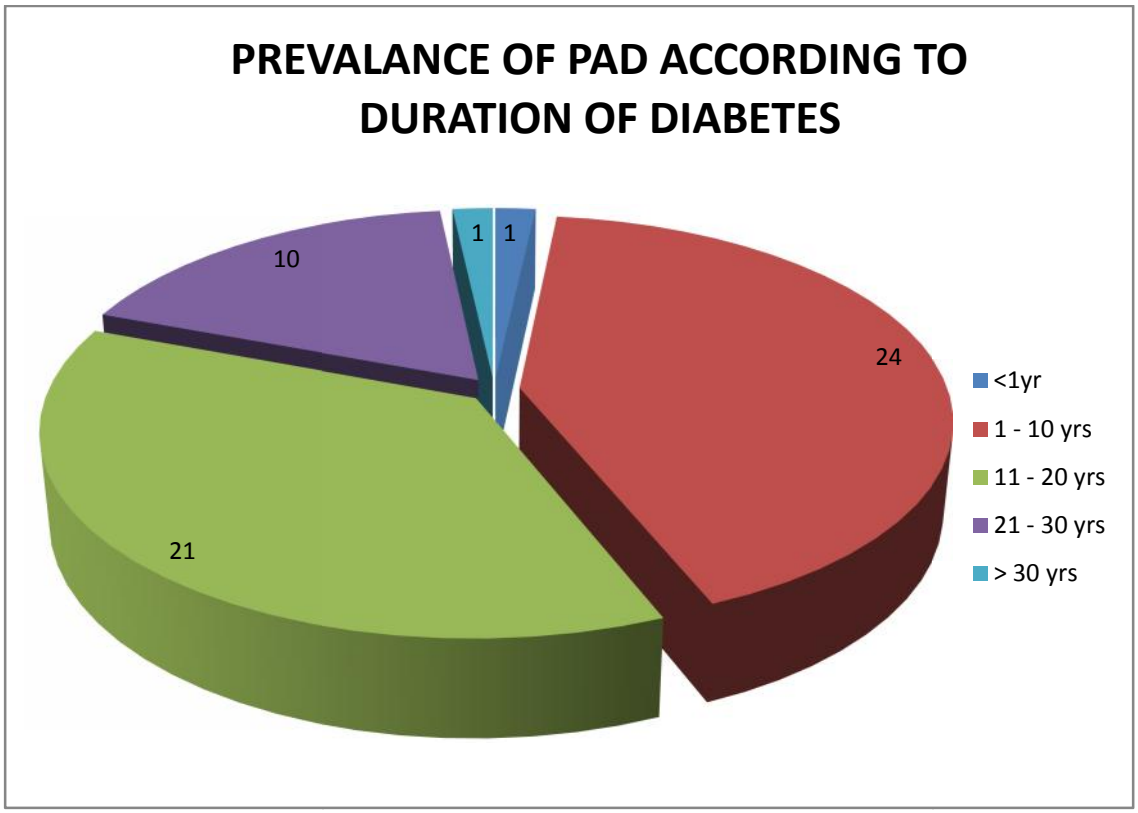
diabetic foot patients = 57/150 = 38%

TOTAL NUMBER OF DIABETIC FOOT	ASSOCIATED WITH PAD	WITHOUT PAD
150	57	93
	38%	62%



PREVALANCE OF PAD ACCORDING TO DURATION OF DIABETES

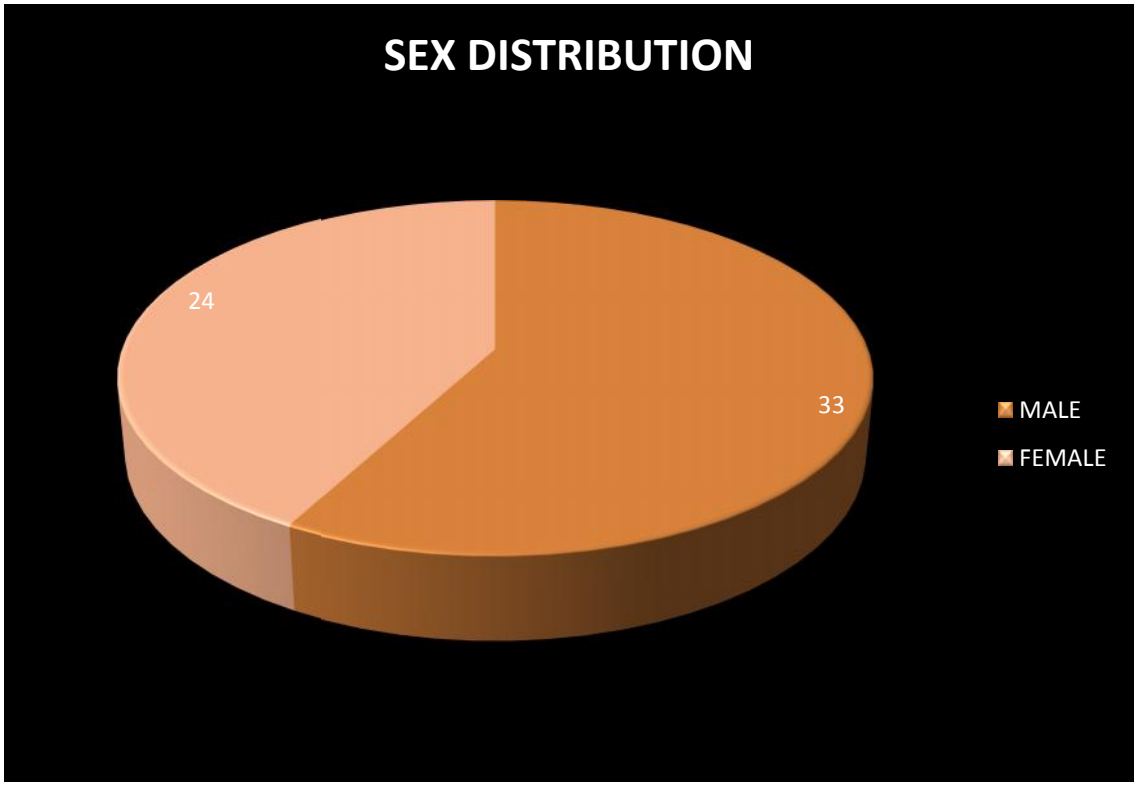
DURATION OF DIABETES(YEARS)	NUMBER OF PAD PATIENTS	PERCENTAGE %
<1	1	**0.66**
1 -10	24	**16**
11 -20	21	**14**
21 -30	10	**6.66**
>30	1	**0.66**



Prevalence of PAD is maximum in 1-10 yrs diabetic duration

SEX DISTRIBTION OF PAD IN DIABETIC FOOT PATIENTS

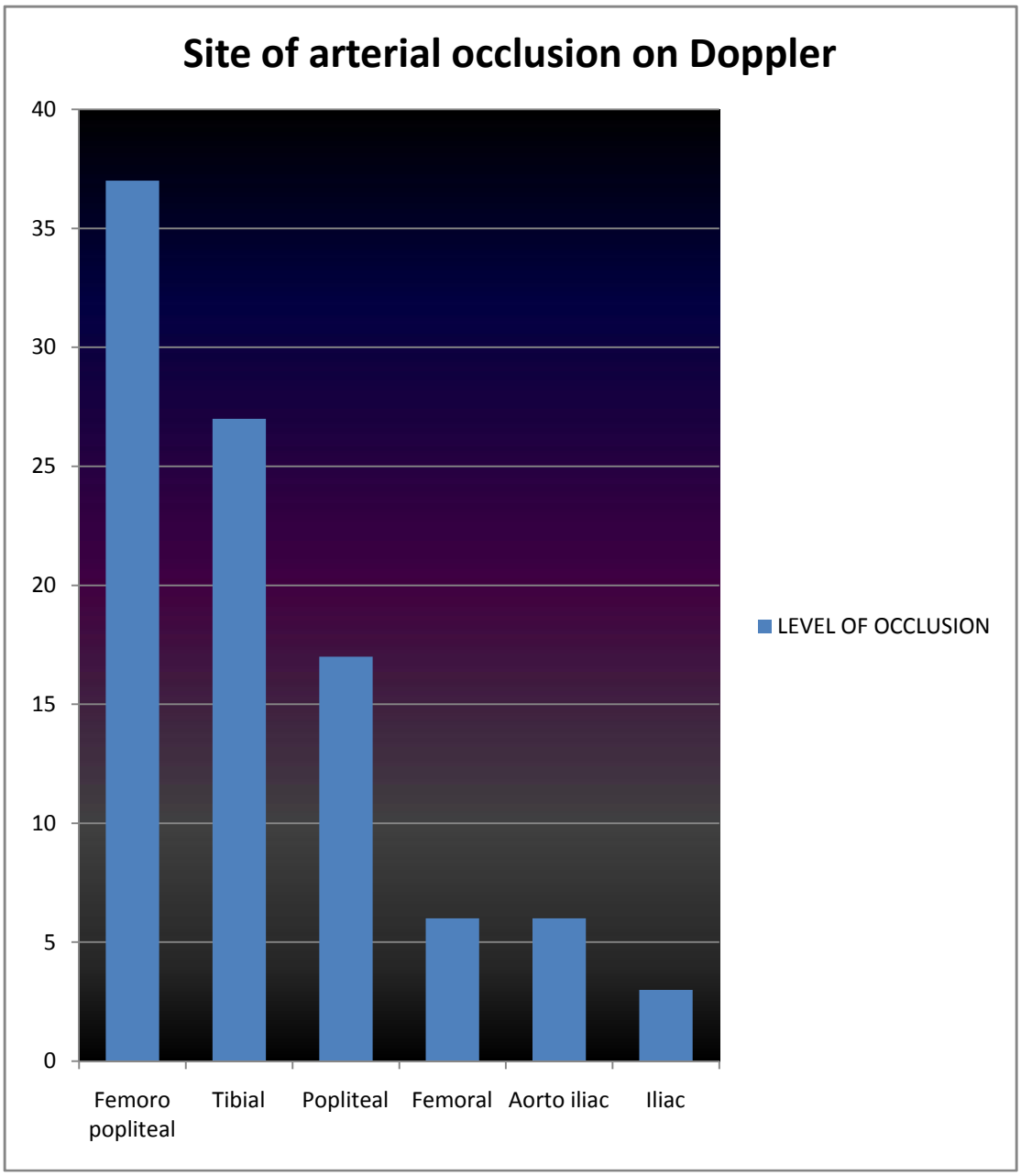
SEX	FREQUENCY	INCIDENCE
MALE	33	**22%**
FEMALE	24	**16%**



Males have higher prevalence than females

DISTRIBUTION OF PERIPHERAL ARTERY DISEASE ACCORDING TO THE SITE OF ARTERIAL NARROWING OR OCCLUSION

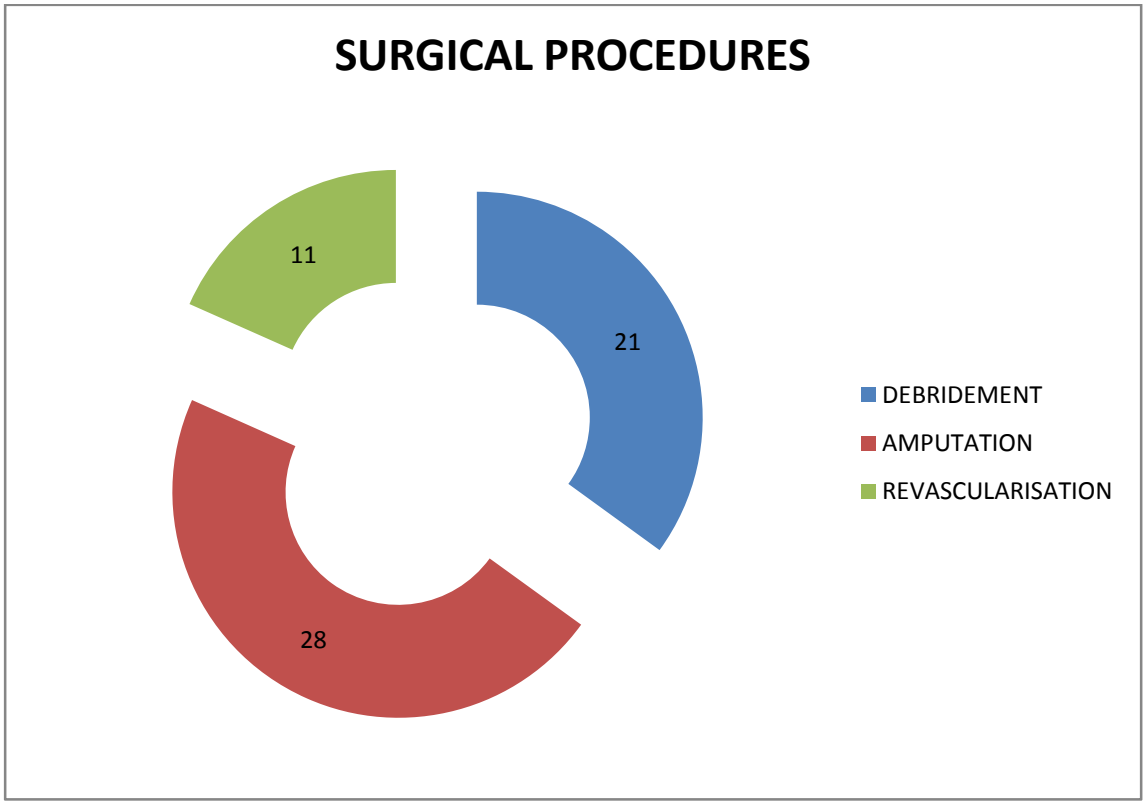
SITE	FREQUENCY	%
AORTO - ILIAC	2	**6**
ILIAC	1	**3**
FEMORAL	2	**6**
FEMORO - POPLITEAL	11	**37**
POPLITEAL	5	**17**
TIBIAL	8	**27**



Occlusions are most common in femoro-popliteal segment followed by tibial segment of arterial tree in PAD associated diabetic foot

SURGICAL PROCEDURES DONE

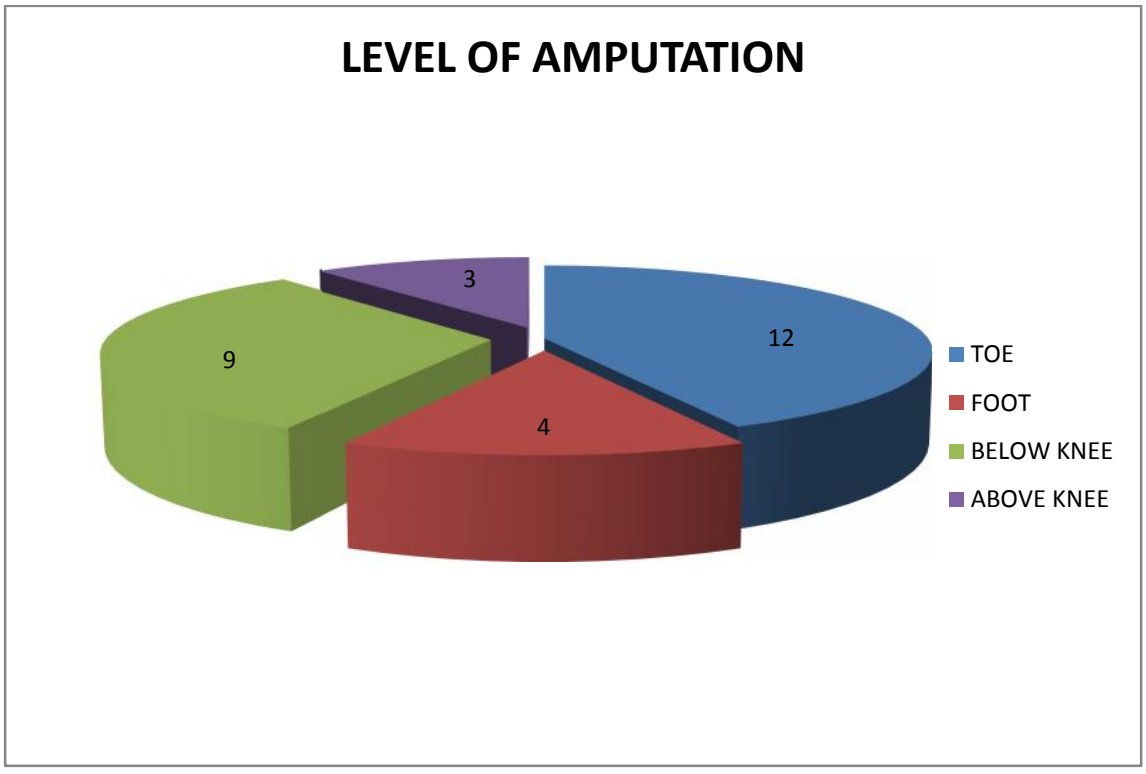
PROCEDURES	FREQUENCY	PERCENTAGE %
DEBRIDEMENT	21	**36.84**
AMPUTATION/ DISARTICULATION	28	**49.12**
REVASCULARISATION	7	**12.28**



Amputations and disarticulations have higher frequency than revascularisations for PAD associated diabetic foot

LEVEL OF AMPUTATION IN DIABETIC FOOT PATIENTS WITH PAD

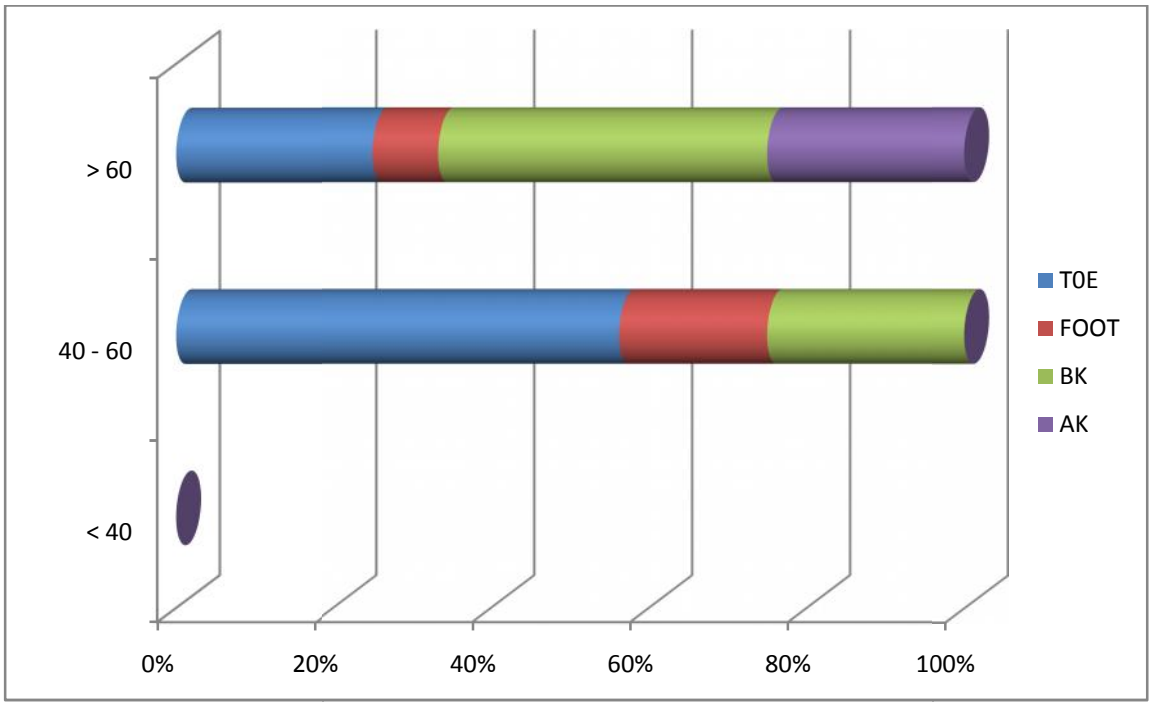
LEVEL OF AMPUTATION	FREQUENCY	PERCENTAGE %
TOE	12	**42.85**
FOOT	4	**14.28**
BELOW KNEE	9	**32.14**
ABOVE KNEE	3	**10.71**



Amputations are maximum at the level of toe followed by below knee level

PREVALENCE OF AMPUTATIONS IN PERSONS WITH PERIPHERAL ARTERIAL DISEASE ACCORDING TO AGE GROUPS AND AMPUTATION LEVEL

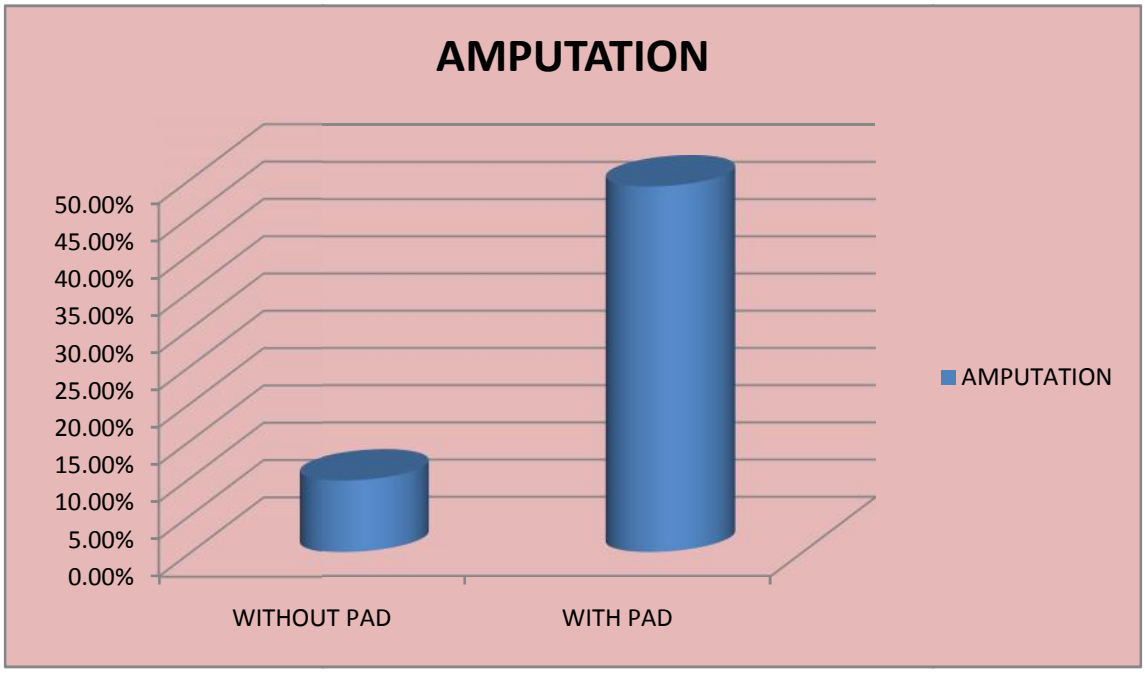
GROUP	TOE	FOOT	BELOW KNEE	ABOVE KNEE	TOTAL	%
<40	0	0	0	0	0	
40-60	9	3	4	0	16	**57.14**
>60	3	1	5	3	12	**42.85**



Maximum amputations are in the age group of 40-60 yrs.

COMPARISON OF AMPUTATIONS IN DIABETIC FOOT PATIENTS WITH AND WITHOUT PAD

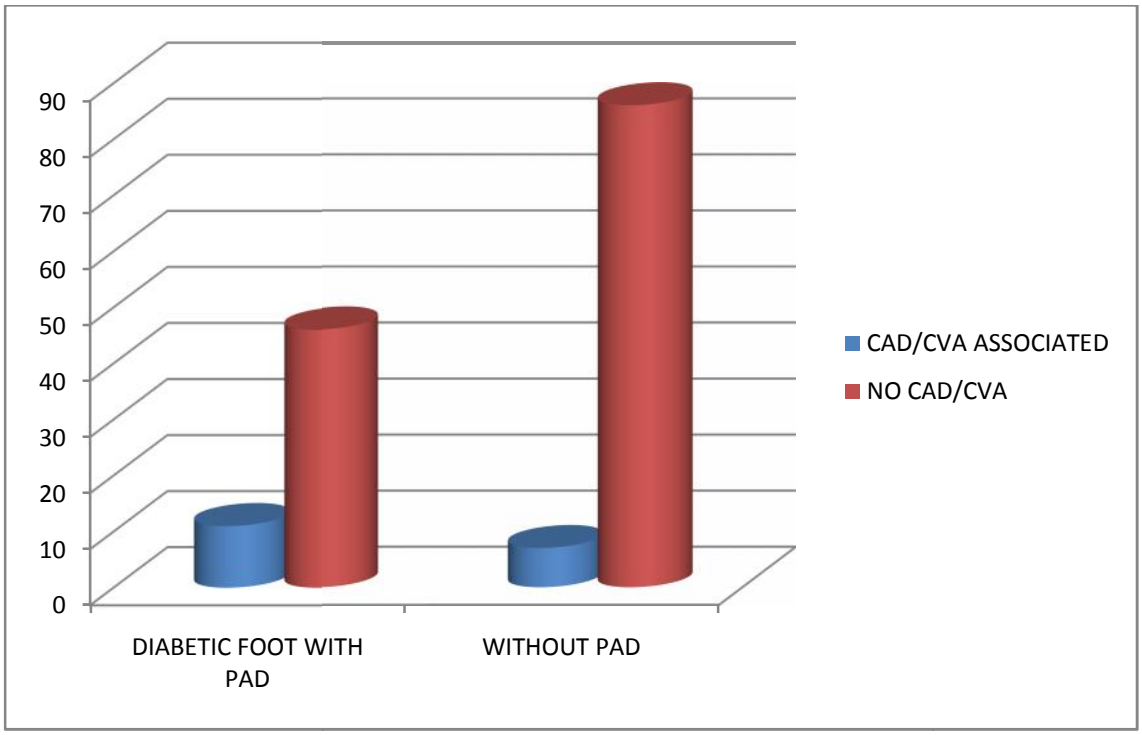
AMPUTATION	FREQUENCY	PERCENTAGE%
WITHOUT PAD	9	**9.6**
WITH PAD	28	**49.12**



PAD influences the outcome of diabetic foot ulcers significantly with higher rate of amputations in PAD patients.

ASSOCIATION OF CAD/CVA IN DIABETIC FOOT PATIENTS WITH AND WITHOUT PAD

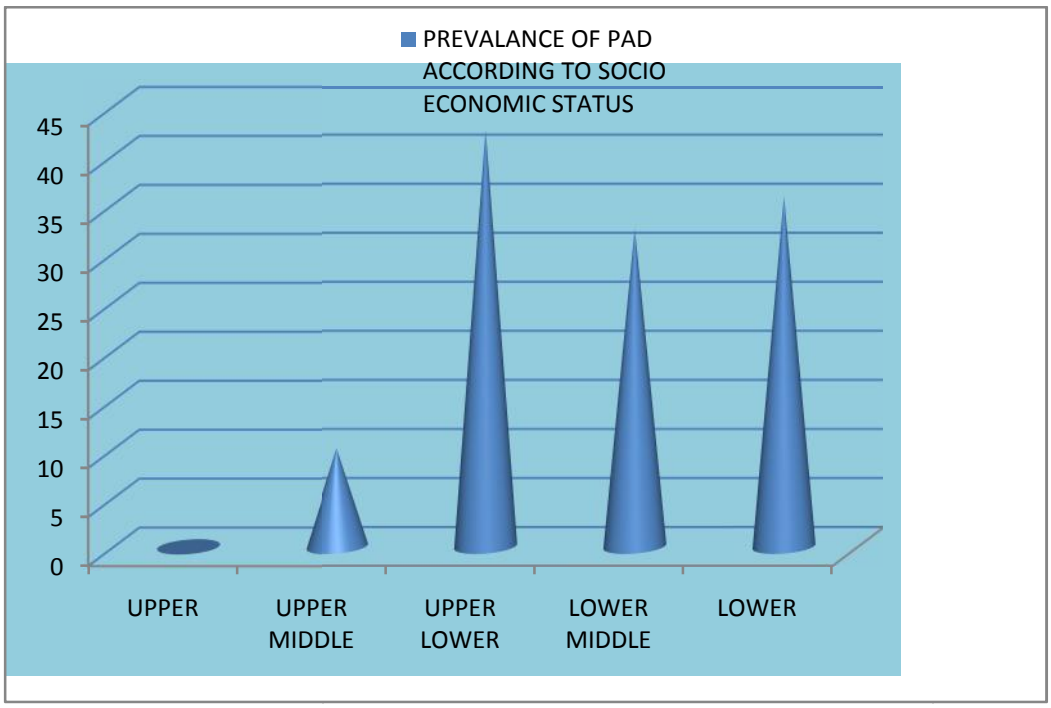
DIABETIC FOOT PATIENTS	CAD/CVA	PERCENTAGE%
WITH PAD (57)	11	**19.29**
WITHOUT PAD (93)	7	**7.52**



CAD & CVA are significantly increased in diabetic foot patients with PAD

PREVALANCE OF PAD ACCORDING TO SOCIO ECONOMIC STATUS

SOCIO ECONOMIC STATUS	FREQUENCY	PERCENTAGE %
UPPER	0	**0**
UPPER MIDDLE	1	**10**
LOWER MIDDLE	12	**32.43**
UPPER LOWER	34	**42.5**
LOWER	10	**35.71**



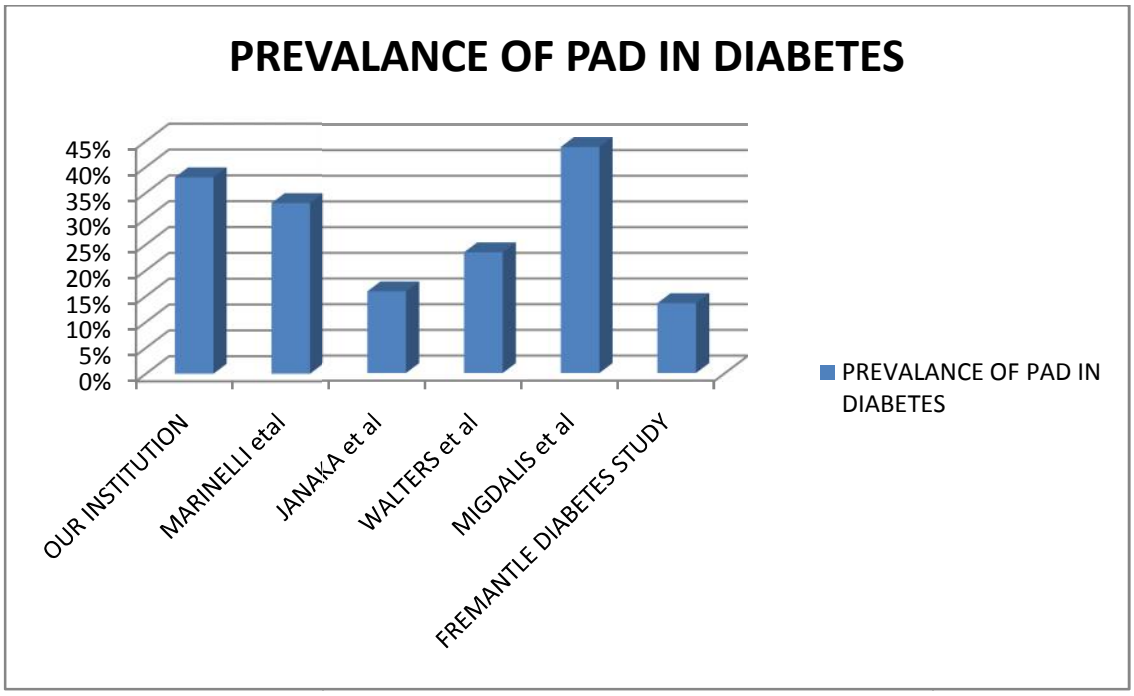
The prevalence of PAD in diabetic foot is higher in lower socioeconomic groups

Analysis

DISCUSSION

COMPARISON OF PREVALANCE OF PAD IN DIABETIC FOOT PATIENTS IN VARIOUS STUDIES

STUDY	PREVALANCE OF PAD
OUR INSTITUTION	38%
MARINELLI et al	33%
JANKA et al	15.9%
WALTERS et al	23.5%
MIGDALIS et al	44%
FREMANTLE DIABETES STUDY	13.6%



It is clear from above chart that, it has been difficult to estimate the prevalence of PAD in patients with diabetes, because the presentation is varied, from numbness due to neuropathy to claudicating pain, ulcer and gangrene.

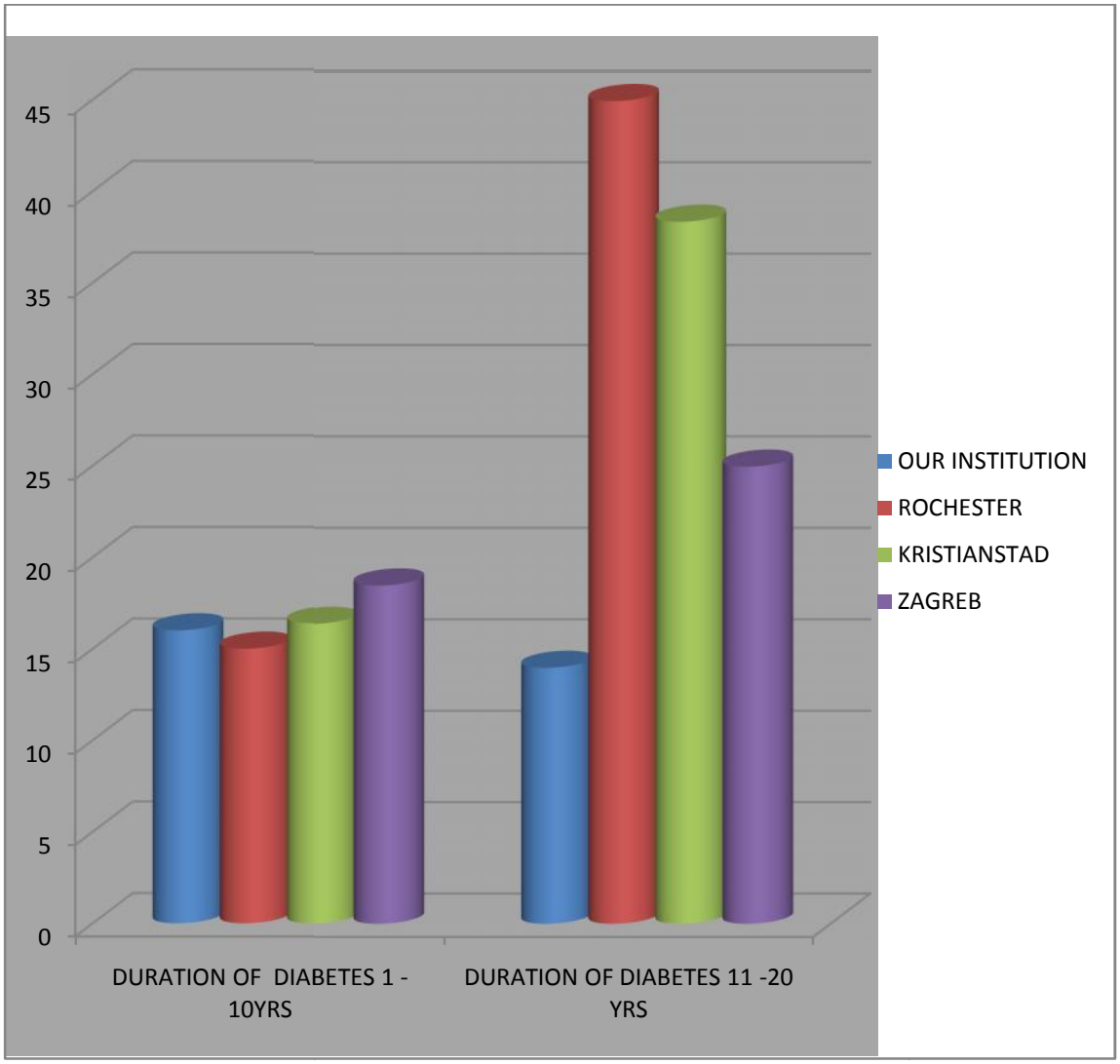
Our study has given a prevalence of 38 % when compared to MARINELLI et al & MIGDALIS et al which have given a prevalence of 33 % & 44 % respectively. i.e 57 patients out of 150 patients had PAD associated with Diabetic foot. The high prevalence of PAD is often under estimated. As some patients in the study were asymptomatic, subclinical PAD is often missed. But with the use of ankle brachial index and Doppler even the subclinical cases were picked up in our study.

COMPARISON OF PREVALANCE OF PAD ACCORDING TO DURATION OF DIABETES IN VARIOUS STUDIES

PREVALANCE	1 - 10 YRS	11 - 20YRS
OUR INSTITUTION	16%	14%
ROCHESTER	15%	45%
KRISTIANSTAD	16.4%	38.4%
ZAGREB	18.5%	25%

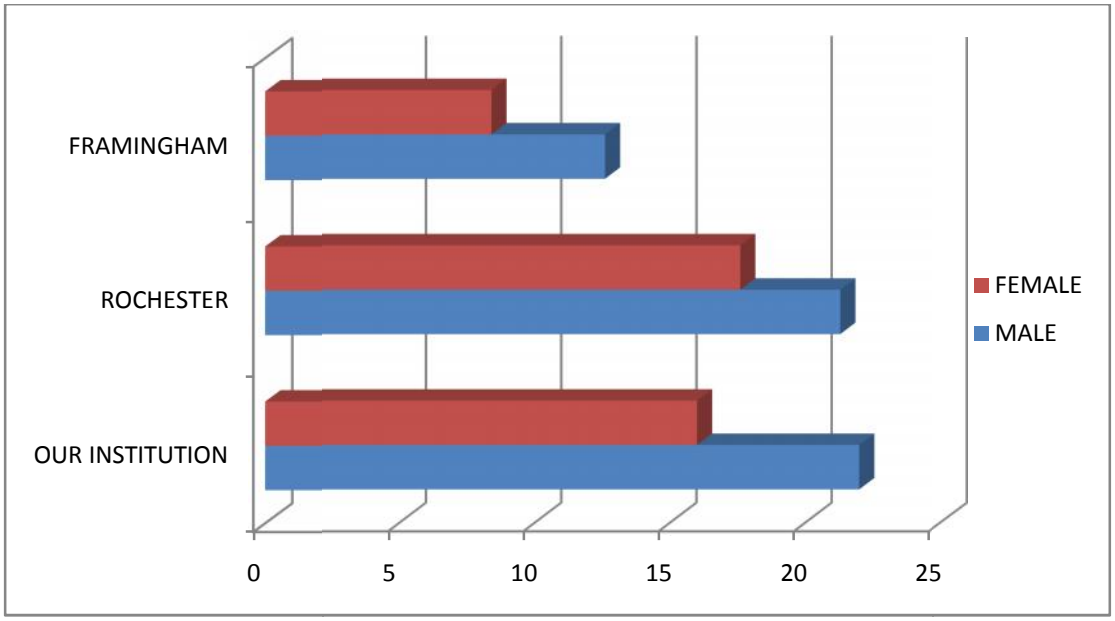
PAD according to the duration of diabetes is maximum between 1 & 10 yrs in the with Prevalence of 16% (24 cases out of 150), closely followed by 11- 20 yrs duration with 14 % prevalence (21 cases out of 150). But in comparison, various studies have shown steady and a significant rise in prevalence of PAD with duration of diabetes[36]. This can be attributed to the

small study group of 150 cases and cases reported in 11- 20 yrs duration & 21 -30 yrs duration were only 19 & 17 respectively.



COMPARISON OF PREVALANCE OF PAD IN BOTH SEXES IN VARIOUS STUDIES

STUDIES	PREVALENCE	
	MALE	FEMALE
OUR INSTITUTION	22	16
ROCHESTER	21.3	17.6
FRAMINGHAM	12.6	8.4

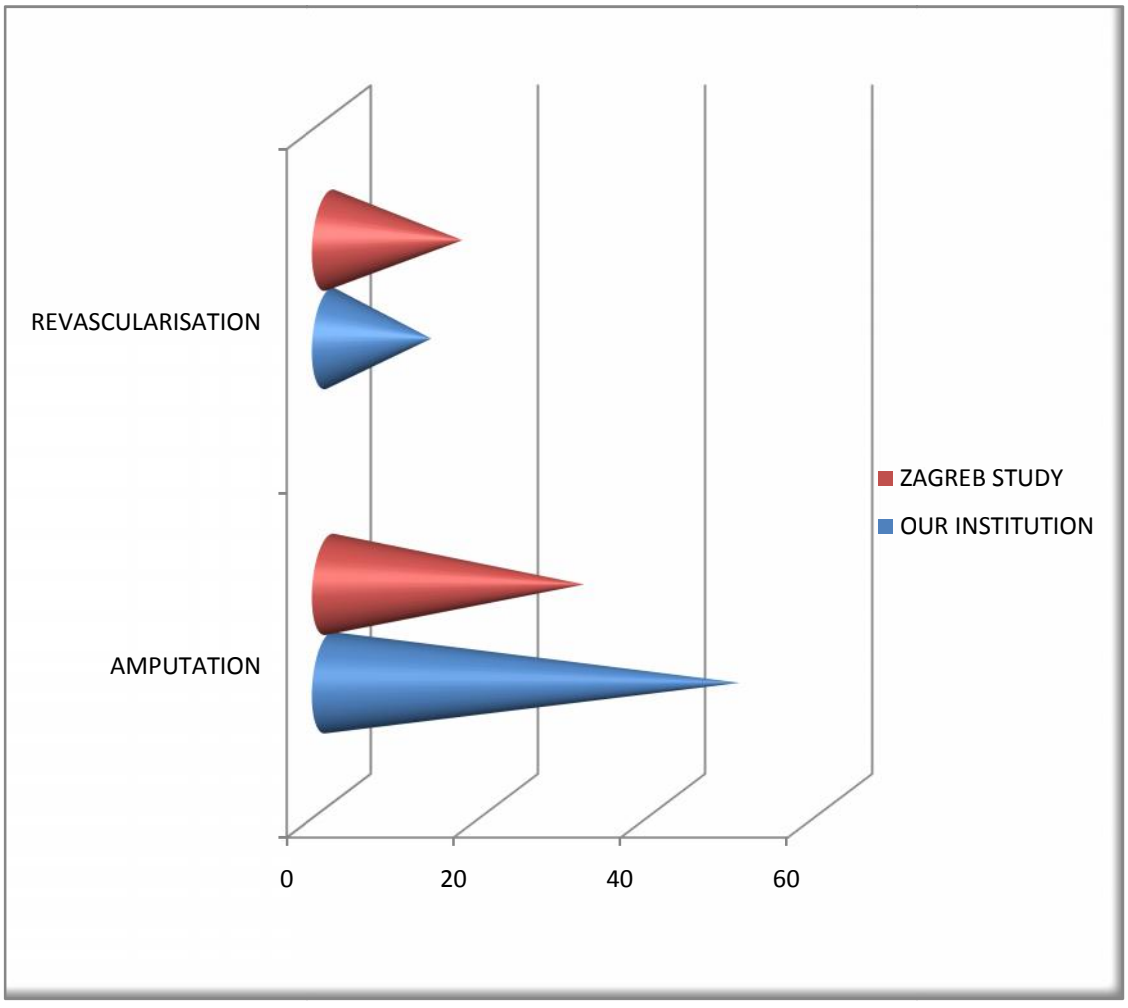


On analyzing the prevalence of PAD in diabetic foot patients according to sex, from my study it is higher in males (22%) than in females (16%).

While comparing with other studies, the result of my study is comparable to rest with higher incidence in males than in females[36].

This also correlates with the existing data that male sex has a higher prevalence of PAD in diabetic foot.

COMPARISON BETWEEN TWO STUDIES ON AMPUTATIONS & REVASCULARISATIONS IN DIABETIC FOOT WITH PAD

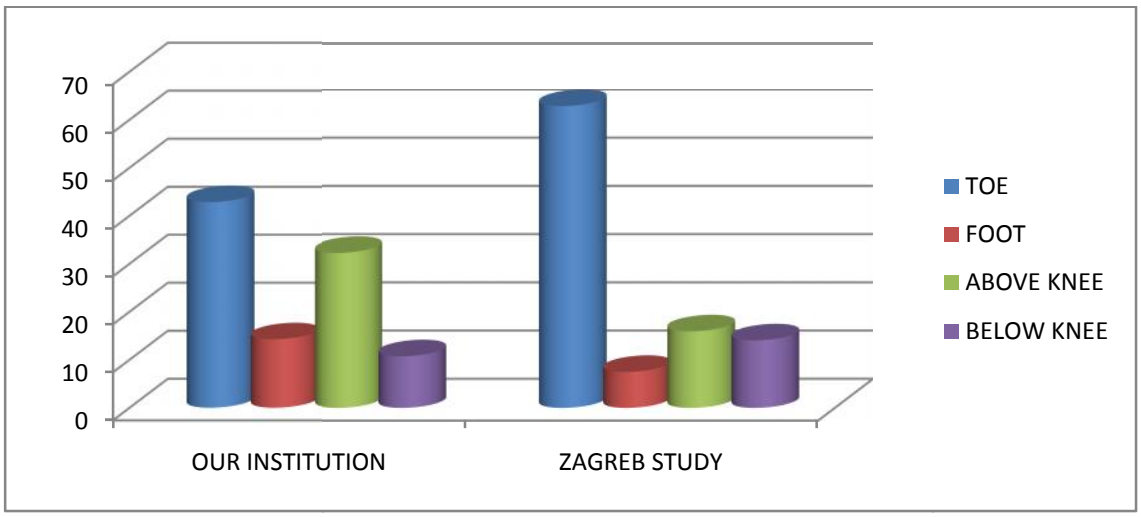


STUDY	AMPUTATION	REVASCULARISATION
OUR INSTITUTION	49.12%	12.28%
ZAGREB	30.57%	16%

On analyzing the data, amputations are higher (49.12 %) than revascularizations (12.28 %) in our institution which is similar to Zagreb study. When compared to the study by Zagreb et al, the percentages of amputations are higher. Many patients for whom amputations were done had stage 4 PVD (late presentation) and had superadded infection. Also since most of our patients are from low socio economic status (lower middle, upper lower and lower), their knowledge of the disease was low and hence presented late.

COMPARISON BETWEEN TWO STUDIES ON THE TYPE OF AMPUTATIONS

STUDY	TOE	FOOT	ABOVE KNEE	BELOW KNEE
OUR INSTITUTION	42.85%	14.28%	32.14%	10.71%
ZAGREB	62.61%	7.47%	15.88%	14.01%



Most of the amputations are minor (toe and foot) which is similar to that of Zagreb study but with slight higher percentage (57.53% Vs 70.08%) because the level of occlusion is highest at femoro-popliteal and tibial vessels according to our study. Above knee amputations are performed in much higher rate in our institution when compared to Zagreb study.

The prevalence of PAD according to socioeconomic status shows higher rate in lower socio economic groups. This finding could be substantiated by the fact that risk factors like smoking and diabetes is higher in lower socio economic groups. A population based study by Knut Kroger et al and Goteborg MONICA study has also concluded that PAD is more prevalent in lower socio economic groups. Also additional behavioral risk factors such as awareness to health or adherence to treatment can be attributed to increased prevalence of PAD in diabetic foot.

CONCLUSION

1. The prevalence of peripheral artery disease in patients with diabetic foot is significantly high i.e. 38 % as per this study. All patients may not be symptomatic or show obvious signs of PVD, but there is a need for properly investigating them.
2. Males have a higher predilection for developing peripheral vascular disease than females.
3. The older the individual, the higher are the chances of having peripheral vascular compromise. The average age of presentation of PAD in diabetics is 40 -60 yrs.
4. The most common level of arterial occlusion in PAD associated diabetic foot is femoro-popliteal segment followed by tibial segment.
5. PAD influences the outcome of diabetic foot ulcers significantly with higher rate of amputations in PAD patients.
6. CAD & CVA are significantly increased in diabetic foot patients with PAD and hence PAD is a marker of systemic vascular disease involving coronary & cerebral vessels, like myocardial infarction (MI), stroke and death.

7. The prevalence of PAD is higher in lower socioeconomic status group.
8. This study and others in the past have consistently proved the benefits and need of investigating diabetics for peripheral vascular disease through clinical palpation for peripheral pulses and ankle brachial index. The use of Arterial Doppler along with clinical methods can be of great significance in the proper evaluation and appropriate management of these individuals.

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PROFORMA

Name: Age/Sex:
Occupation: Socioeconomic status:
IP No: Phone No:
DOA: DOS: DOD:
DIAGNOSIS:
HISTORY:

- Ulcer
- Discharge
- Numbness
- Claudication pain
- Discolouration
- Joint immobility
- Trauma
- Diabetic h/o-Duration
- Family h/o
- Past h/o surgery (amputations/disarticulations)
- Past h/o CVA/CAD
- Comorbid illness

GENERAL EXAMINATION: general condition
Pallor
Pedal edema
Generalized lymphadenopathy
LOCAL EXAMINATION :
1.Ulcer : Site & Size
shape
extent
floor and base
discharge

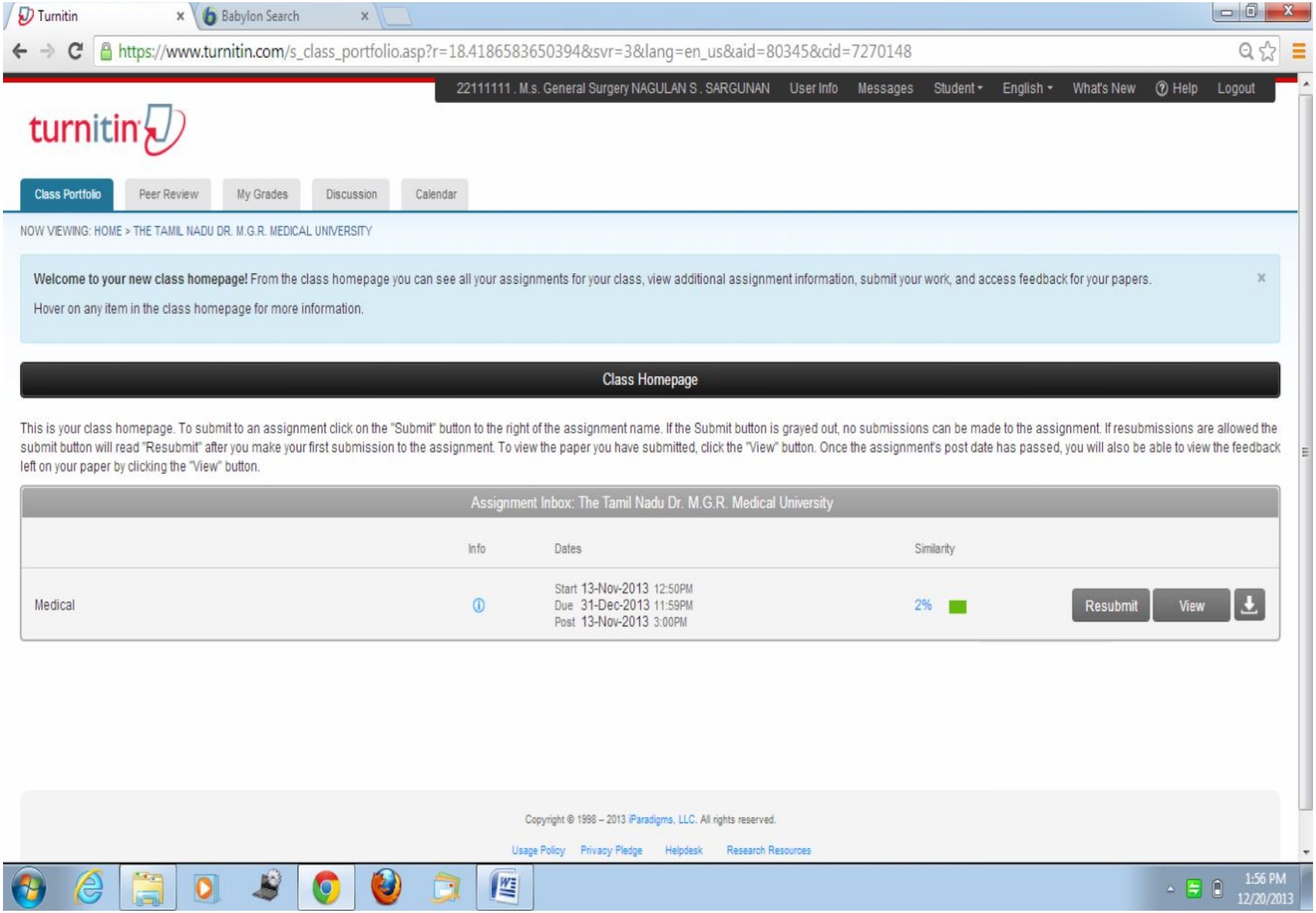
2. Sensation:
   - Touch
   - Pain
   - Temperature
   - Vibration perception
3. Peripheral pulsation:
   - Superficial temporal
   - External carotid
   - Radial
   - Femoral
   - Popliteal
   - Posterior tibial
   - Anterior tibial
   - Dorsalis paedis
4. Joint mobility : Active
   Passive
5. Fontaine stage:

INVESTIGATIONS:
   - Renal function test
   - Lipid Profile
   - X-ray foot (AP/Lat)
   - Doppler study
   - Ankle Brachial Index(ABI)
   - Echocardiogram

PREVENTIVE MEASURES:

TREATMENT (Surgery/Procedure done):

REHABILITATION: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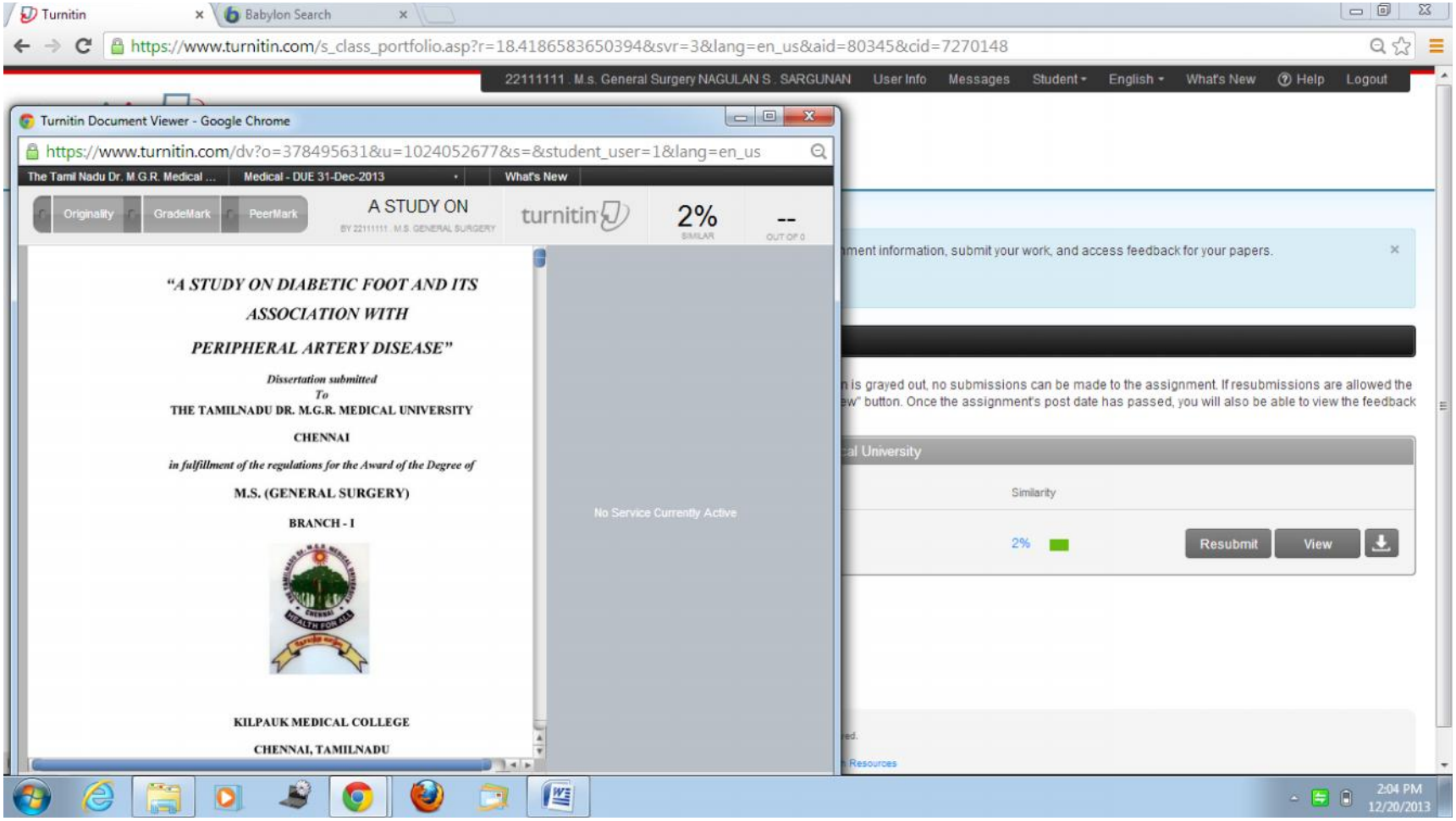
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Dissertation submitted
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CHENNAI
in fulfillment of the regulations for the Award of the Degree of
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Sl.No	Name	IP/OP No	Age	Sex	Duration of DM	Socioeconomic status	Foot ulcer/cellulitis	toe/foot Gangrene	ABI	Level of occlusion	Fontaine stage	Deformity	Surgery/Procedure	CAD/CVA	follow up
1	Dhamodaran	1326356	56	M	5 yrs	lower	yes	no	1.1			no	debridement	no	Nonhealing Ulcer
2	Munusamy	1325767	48	M	8 yrs	upper lower	no	yes	1.2			yes	toe disarticulation	no	healed ulcer
3	Rajaiah	1382340	55	M	2 yrs	upper lower	yes	no	1			no	debridement	no	Ulcer
4	Lakshmi.S	1346958	54	F	20yrs	upper lower	no	yes	0.2	femoro popliteal	stage 4	no	BK amputation	N0	dead
5	Murali	1324566	55	M	5 yrs	lower	no	yes	0.6	tibial	stage 3	no	toe disarticulation	no	Nonhealing Ulcer
6	Cherian	1324685	45	M	1 yr	upper middle	yes	no	1			no	debridement	no	healed ulcer
7	Pal Pandi	1029273	57	M	22yrs	lower	no	yes	0.3	femoro popliteal	stage 4	yes	toe disarticulation	no	dead
8	Murugesan.G	364479	40	M	1 yr	upper lower	no	no	1		stage 1	no	MCR Chappals	no	healed ulcer
9	Saroja	12047	48	F	6 mon	upper lower	yes	no	1.2			no	debridement	no	healed ulcer
10	Mariamma	109364	52	F	4 yrs	upper middle	no	yes	0.6	tibial	stage2	no	toe disarticulation/bypass	no	healed Ulcer
11	Rajagopal	1320475	49	M	4 yrs	upper lower	no	yes	1.1			yes	toe disarticulation	no	
12	Muthu Krishnan	1324857	51	M	3 yrs	lower middle	yes	no	1			no	debridement/dressing	no	lost
13	Krishna Moorthy	1334057	52	M	10 yrs	lower middle	no	yes	0.3	femoral		yes	forefoot amputation	no	
14	Ramachandran	1340875	47	M	2 yrs	upper lower	yes	no	1.1			no	debridement	no	healing ulcer
15	Abeena	1324758	72	F	25 yrs	upper lower	no	yes	0.3	aorto iliac	stage 4	no	AK amputation	CAD+CVA	dead
16	Rajamma	1350686	65	F	16 yrs	upper lower	no	yes	0.3	femoro popliteal		no	BK amputation	no	
17	Ameena Beevi	795950	50	F	4 yrs	lower middle	no	no	0.9		stage 1	no	MCR Chappals	no	lost
18	Thangaraman	39475	53	M	3mon	lower	yes	no	1			no	cleaning & dressing	no	lost
19	Murali.A	47484	65	M	9 yrs	lower middle	yes	no	1.1			no	debridement	no	healed ulcer
20	Muniamma	203844	40	F	15yrs	upper lower	no	no	0.8		stage 1	no	MCR Chappals	no	
21	Pandiaraj	102837	48	M	5 yrs	upper lower	no	no	0.6		stage 2	no	MCR Chappals	no	toe disart
22	Duraiamma	1340485	62	F	26yrs	upper lower	no	yes	0.4	popliteal		yes	toe disarticulation	NO	
23	Muthumari	1384048	62	M	5 yrs	upper lower	yes	no	1			no	debridement	no	healing ulcer
24	Muzhaffar Khan	1329494	54	M	8 yrs	upper lower	no	yes	0.3	tibial	stage 4	yes	toe disarticulation/bypass	no	healed
25	Kannaiah	1365474	43	M	10 mon	lower middle	yes	no	1			no	debridement	no	healed ulcer
26	Dhanasekar	1367477	56	M	12 yrs	upper lower	no	yes	0.4	tibial	stage 4	yes	toe disarticulation	CAD	ulcer
27	Rajeshwari	12879	54	F	10 yrs	upper lower	yes	no	1			no	debridement/dressing	no	healed ulcer
28	Muthupandi	1386373	40	M	3 yrs	lower middle	yes	no	1			no	debridement	no	Nonhealing Ulcer
29	Palani	129077	61	M	15 yrs	upper lower	yes	no	0.4	tibial		yes	bypass	no	Healed
30	Shankar	136960	55	M	7 yrs	lower middle	no	no	1			no	MCR Chappals	no	lost
31	Thangam	1320974	45	F	2 yrs	upper lower	yes	no	1			no	debridement	no	healing ulcer
32	Lakshmi.R	1320955	65	F	22 yrs	upper lower	yes	yes	0.3	femoro popliteal	stage 4	no	BK amputation	no	lost
33	Ranganathan	1320599	58	M	5 yrs	lower	no	no	1			yes	MCR footwear	no	
34	Mahalakshmi	239485	62	F	11 mon	lower middle	yes	no	1.1			yes	debridement	no	Nonhealing Ulcer
35	Pandu	1320394	60	M	29yrs	upper lower	yes	yes	0.3	popliteal	stage 3	yes	forefoot amputation	CAD	healed
36	Kannan	23645	72	M	8 yrs	lower middle	no	no	1.1			yes	MCR footwear	no	lost
37	Mariamma.P	1364964	58	F	15yrs	upper lower	yes	yes	0.4	tibial		no	toe disarticulation/bypass	NO	lost
38	Govindan	304758	64	M	6 yrs	lower middle	no	no	1			no	MCR footwear	no	Ulcer
39	Rathi	1365487	58	F	5 yrs	lower	yes	no	1			no	debridement	no	Nonhealing Ulcer

40	Govindamma	1326578	60	F	4 yrs	lower middle	no	no	1.1			yes	MCR footwear	no	lost
41	Palani.M	43957	56	M	9 yrs	lower middle	yes	no	0.9		stage 1	yes	debridement	no	healed ulcer
42	Muthu	249907	57	M	3 yrs	upper lower	no	no	1.1			no	MCR Chappals	no	
43	Kaliammal	34755	54	F	8 mon	lower middle	no	no	1			no	debridement	no	lost
44	Rani	587869	52	F	7 yrs	lower middle	no	no	0.8		stage 2	no	MCR Chappals	no	healed
45	Kokila	1326656	55	F	8 yrs	upper lower	yes	no	1.2			no	debridement	no	healed ulcer
46	Krishnan	1375687	76	M	20 yrs	lower	yes	yes	0.3	femoral		yes	BK amputation	NO	
47	Ganesh	1324356	53	M	8 yrs	lower	no	no	0.9		stage 1	no	MCR Chappals	no	
48	Mariamma	1320076	66	F	30yrs	lower	no	yes	0.6	tibial	stage 3	no	debridement/bypass	no	toe disart
49	Govindhan	556764	65	M	10 yrs	lower	yes	no	1			no	debridement	CAD/CVA	dead
50	Indhumathy	1386555	57	F	8 yrs	upper lower	no	no	1.1			no	MCR Chappals	no	
51	Sarasu	1358576	56	F	5 yrs	upper lower	yes	no	0.8		stage 1	yes	debridement	NO	Nonhealing Ulcer
52	Mathi	1327658	49	M	3 yrs	lower middle	yes	no	1			no	cleaning & dressing	no	healing ulcer
53	Janaki	1326575	38	F	4 yrs	lower	no	no	1			yes	MCR Chappals	no	
54	Rajesh.T	1347565	54	M	7 yrs	lower	no	no	1			no	MCR Chappals	no	
55	Ganesan.M	1324758	39	M	2 yrs	lower middle	yes	no	0.8		stage 2	no	debridement	no	
56	Mariamma.N	1357367	49	F	6 yrs	lower middle	no	no	0.9			no	debridement & dressing	no	lost
57	Kalidas	1369447	55	M	4 yrs	upper lower	no	no	1			yes	MCR Chappals	no	
58	Fardha Begam	43477	67	F	17 yrs	upper lower	yes	yes	0.3	femoro popliteal	stage 4	yes	toe disarticulation/bypass	CAD/CVA	dead
59	Anvar	25578	56	M	4 yrs	lower middle	no	no	1.1			no	MCR Chappals	no	lost
60	Sarnath Jain	1325766	36	M	5 yrs	lower middle	yes	no	1			no	debridement	no	healed Ulcer
61	Marimuthu.C	233579	60	M	10 yrs	upper lower	no	yes	0.4	tibial	stage 4	no	ferofoot amputation	CAD	BK Amput
62	Chella Durai	95858	66	M	12 yrs	upper lower	yes	no	1			yes	debridement & dressing	no	healed ulcer
63	Pavithra	1389575	45	F	6 yrs	lower middle	yes	no	0.8		stage 2	no	debridement & dressing	no	lost
64	karthic	1368475	47	M	4 yrs	lower middle	no	no	1.1			no	MCR footwear	no	Ulcer
65	Chakravathi	1348869	40	M	1 yr	lower	yes	no	1.1			no	cleaning & dressing	no	Nonhealing Ulcer
66	Dinakar	123275	60	M	13 yrs	lower	no	yes	0.3	femoro popliteal		no	toe disarticulation	NO	
67	Dhanasekar.I	1324678	58	M	6 yrs	lower middle	yes	no	1			no	debridement	no	healing ulcer
68	Shanthi	132445	51	M	8 yrs	lower	no	no	1			no	cleaning & dressing	no	lost
69	Sangeetha	1324567	55	F	6 yrs	upper lower	yes	no	0.9			no	debridement & dressing	no	healed ulcer
70	Palpandi.E	1345577	61	M	4 yrs	upper lower	no	no	1.2			no	toe disarticulation	CVA	
71	Murali Ganesh	1324456	54	M	7 yrs	upper lower	no	no	1.1			yes	MCR Footwear	no	healed ulcer
72	Rana Prathap	1324456	53	M	5 yrs	upper lower	yes	no	1			no	debridement	no	healing ulcer
73	Brammaraj	64547	40	M	2 yrs	lower	yes	no	0.8		stage 2	no	debridement & dressing	no	healing ulcer
74	Balaraman	1368575	46	M	6 yrs	lower	yes	no	1			yes	cleaning & dressing	no	lost
75	balasubramanian	1328575	78	F	25 yrs	upper lower	no	yes	0.4	ilaic occlusion	stage 4	no	AK amputation	no	dead
76	Vishwasam	45767	67	M	13 yrs	lower middle	yes	no	0.6	tibial	stage 3	no	debridement/bypass	NO	forefoot ampu
77	Samson	93085	43	M	3 yrs	lower middle	yes	no	1			no	cleaning & dressing	no	dead
78	Siva Kumar	1324567	56	M	9 yrs	upper lower	yes	no	1			no	cleaning & dressing	no	lost
79	Chellapa	1326788	49	M	6 yrs	lower	yes	no	1			no	debridement & dressing	no	lost
80	Meenakshmi	1379980	67	F	11 yrs	lower	no	no	0.9		stage 1	no	MCR footwear	no	Ulcer

81	Sridevi	1374696	45	F	6 mon	upper lower	no	no	1.1			no	MCR Footwear	no	
82	Muragan.p	23878	56	M	9 yrs	upper lower	yes	no	1			no	toe disarticulation	no	lost
83	Palani	1379799	55	M	3 yrs	upper lower	yes	no	1.2			no	cleaning & dressing	CAD	healed ulcer
84	Kunjithapadham	34877	43	M	4 yrs	lower middle	no	no	1			yes	MCR footwear	no	
85	Pavadasami	1376595	49	M	7 yrs	upper lower	yes	no	1.1			no	cleaning & dressing	no	healing ulcer
86	Sabari	1378536	39	M	2 yrs	upper lower	no	no	1			no	MCR footwear	no	lost
87	Kaliammal	1378474	83	M	26 yrs	upper lower	no	yes	0.3	femoro popliteal		yes	BK amputation	no	
88	Mahendran	205758	53	M	15yrs	upper lower	yes	no	0.7		stage 2	no	debridement & dressing	no	healed ulcer
89	Manonmani	1383490	49	M	2 yrs	upper lower	yes	no	1			no	cleaning & dressing	no	lost
90	Saroja	1386557	55	F	5 yrs	upper lower	yes	no	1			yes	cleaning & dressing	no	healed ulcer
91	Iqbal	1386464	60	M	9 yrs	upper lower	no	yes	0.4	popliteal		yes	BK amputation	CAD	alive
92	Mahalakshmi	1386468	59	F	10 yrs	lower	no	no	1			no	MCR footwear	no	
93	Jhansi	674846	51	F	6 yrs	lower middle	yes	no	1			no	debridement	CAD	healed ulcer
94	Rihan	49586	48	M	4 yrs	upper lower	no	no	0.9		stage 1	no	MCR footwear	no	lost
95	Munna.P	358598	62	M	12 yrs	lower middle	yes	yes	0.4	tibial	stage 4	no	toe disarticulation/bypass	no	healed
96	Lakshmanan	374689	42	M	4 yrs	upper lower	yes	no	0.7		stage 2	no	debridement & dressing	NO	dead
97	Hanumanthaiya	1384665	50	M	3 yrs	lower	no	no	1.1			no	MCR footwear	no	
98	Shabna Asmi	1380494	55	F	8 yrs	upper lower	yes	no	0.9		stage 1	no	cleaning & dressing	no	ulcer
99	Raghavayya	1380404	61	M	8 yrs	upper lower	no	no	1.2			yes	MCR footwear	no	
100	Ethiraj pillai	1336635	65	M	13 yrs	upper lower	no	yes	0.4	popliteal		yes	forefoot amputation/bypass	no	healed
101	Devasundari	1335839	75	M	24 yrs	upper lower	yes	yes	0.3	femoro popliteal	stage 4	no	BK amputation	CAD/CVA	
102	Arumugam	1333272	40	M	2 yrs	upper lower	no	no	0.9		stage 1	no	MCR footwear	no	lost
103	Duraisamy	1336264	80	M	23YRS	lower middle	yes	no	0.9			no	debridement & dressing	NO	Nonhealing Ulcer
104	Gnanamoorthy	1335004	42	M	8 mon	lower	yes	no	1.2			no	cleaning & dressing	no	lost
105	Meenatchi	1334867	72	F	31 yrs	upper lower	no	yes	0.3	aorto iliac	stage 4	yes	AK amputation	CAD	
106	Valliammal	1336566	70	F	15 yrs	lower	yes	no	1.2			yes	debridement & dressing	CVA	Nonhealing Ulcer
107	Balasubramanian	1336260	57	M	4 yrs	upper lower	yes	no	1.1			no	toe disarticulation	no	healed ulcer
108	Ramamoorthy	1334044	65	M	8 yrs	upper lower	no	no	1			no	MCR footwear	no	
109	Doss	1331132	59	M	3 yrs	lower middle	no	yes	1.2			yes	debridement	no	healed ulcer
110	Senthil Kumar	55754	38	M	6 mon	upper lower	no	no	0.9		stage 1	no	MCR footwear	no	lost
111	Sarasu	68364	56	F	5 yrs	upper lower	no	no	1.1			no	MCR footwear	no	
112	Lakshmi.G	1345968	55	F	2 yrs	lower middle	yes	no	1.2			yes	cleaning & dressing	no	lost
113	Arumugam	1338272	77	M	25yrs	lower	yes	yes	0.6	tibial	stage 3	no	debridement/Bypass	no	
114	Francis	56384	57	F	10 yrs	upper lower	no	yes	1			yes	cleaning & dressing	no	
115	Dinakar	1357464	48	M	4 yrs	lower	no	no	1.1			no	MCR footwear	no	lost
116	Balachander	336474	45	M	7 yrs	upper lower	yes	yes	0.3	femoro popliteal	stage 4	yes	BK amputation	no	
117	Madura Ganesh	1349485	57	M	6 yrs	lower	no	no	1.2			yes	MCR footwear	no	Ulcer
118	Vembar	1337474	76	M	22 yrs	upper lower	yes	no	1			no	debridement	CAD	healed ulcer
119	Janaki	294847	61	F	20YRS	lower middle	no	no	0.9		stage 1	no	MCR footwear	no	no ulcer
120	Farah	1324435	41	M	10 mon	upper lower	yes	no	1.2			no	cleaning & dressing	no	lost
121	Durairaj	1379494	71	M	13 yrs	upper lower	no	no	1			no	BK amputation	no	

122	Sundarammal	43626	60	F	9 yrs	upper lower	yes	no	1			no	debridement & dressing	no	healed ulcer
123	Arun	134255	50	M	3 yrs	upper lower	no	no	1.1			no	toe disarticulation	no	lost
124	Chandar	1325546	55	M	7 yrs	lower	yes	yes	1.1			no	debridement	no	healed ulcer
125	Maheshwaran	1342244	62	M	3 yrs	lower middle	yes	no	1			no	cleaning & dressing	no	Nonhealing Ulcer
126	Selvapathi	1337657	52	M	4 yrs	upper lower	no	no	1.2			yes	MCR footwear	no	lost
127	Banumathi	1379596	48	F	7 mon	upper lower	no	no	1.2			no	MCR footwear	no	Ulcer
128	Karthic	23776	59	M	10 yrs	upper lower	no	yes	0.6	femoro popliteal	stage 4	no	toe disarticulation	NO	healed ulcer
129	Ayyapa Murugan	857589	62	M	17 yrs	upper lower	yes	no	0.9			no	debridement & dressing	CAD	toe disart
130	Murugesan.C	1349293	59	M	8 yrs	lower	yes	no	1			no	cleaning & dressing	no	healed ulcer
131	Rajendran	1334667	70	M	29 yrs	upper lower	yes	no	1			no	debridement & dressing	no	lost
132	Rajaprabakaran	1324467	58	M	4 yrs	upper lower	yes	no	1.1			yes	cleaning & dressing	no	healed ulcer
133	Mahesh	237759	53	M	7 yrs	upper lower	no	no	1.1			yes	MCR footwear	no	
134	Indhu .R	1345598	76	F	29YRS	upper lower	no	no	0.9		stage 1	yes	MCR footwear	no	lost
135	Madhu	1358384	57	F	8 yrs	upper lower	yes	no	1.1			no	cleaning & dressing	CAD	lost
136	Gawthami	1359494	72	F	15 yrs	upper lower	no	yes	1			no	debridement	no	Nonhealing Ulcer
137	Babu Antony	97789	47	M	3 mon	upper lower	yes	no	1.2			yes	cleaning & dressing	no	healed ulcer
138	Ravichander	53536	54	M	9 yrs	lower middle	no	no	1			no	toe disarticulation	no	
139	Thomas	16648	45	M	4 yrs	upper lower	yes	no	1			yes	cleaning & dressing	no	healed ulcer
140	Anand	1339394	59	M	8 yrs	lower middle	no	no	1.2			no	MCR footwear	no	
141	Siva rao	1329690	60	M	27YRS	lower middle	yes	no	0.6	popliteal	stage 3	yes	toe disarticulation/bypass	no	healed ulcer
142	Paul Raj	1369393	49	M	2 yrs	lower middle	no	no	1.2			no	MCR footwear	no	lost
143	Rajalakshmi	63747	47	F	6 yrs	upper lower	no	no	0.8		stage 1	yes	MCR footwear	no	Ulcer
144	P.Mani	1328696	50	M	4 yrs	upper lower	no	no	1.1			no	MCR footwear	no	
145	Sridhar	1326869	60	M	3 yrs	upper lower	no	no	1.2			yes	cleaning & dressing	no	lost
146	Madhumathi	1360060	58	F	21YRS	lower	yes	no	0.3	femoro popliteal	stage 4	no	BK amputation	CAD	
147	Hari	1329797	49	M	2 yrs	lower	yes	no	1.1			no	cleaning & dressing	no	lost
148	Basha	17858	63	M	13 yrs	upper lower	yes	no	1			no	BK amputation	no	Nonhealing Ulcer
149	Selvi	1329797	49	F	6 mon	lower	yes	no	1.2			yes	cleaning & dressing	no	healed ulcer
150	Mahesh kumar	1349787	50	M	3 yrs	upper lower	yes	no	0.9			no	cleaning & dressing	NO	healed ulcer